Presented by

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ROYAL COMMISSION ON SEWAGE DISPOSAL.

INTERIM REPORT

OF

THE COMMISSIONERS

APPOINTED IN 1898

TO INQUIRE AND REPORT WHAT METHODS OF

TREATING AND DISPOSING OF SEWAGE

(Including any Liquid from any Factory or Manufacturing Process)

MAY PROPERLY BE ADOPTED.

Presented to both Houses of Parliament by Command of His Majesty.

LONDON:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE,
BY WYMAN AND SONS, LIMITED, FETTER LANE, E.C.

And to be purchased, either directly or through any Bookseller, from
EYRE and SPOTTISWOODE, East Harding Street, Fleet Street, E.C., and
32, Abingdon Street, Westminster, S.W.; or
OLIVER and BOYD, Edinburgh; or
E. PONSONBY, 116, Grafton Street, Dublin.

1902.

[Cd. 685.] *Price 2d.*

VICTORIA R.

Victoria, by the Grace of God, of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith: To Our Right Trusty and Right Well-beloved Cousin, Walter Stafford, Earl of Iddesleigh, Companion of Our Most Honourable Order of the Bath; Our Trusty and Well-beloved Sir Richard Thorne Thorne, Knight Commander of Our Most Honourable Order of the Bath, Medical Officer of the Local Government Board; Our Trusty and Well-beloved Constantine Phipps Carey, Esquire, Lieutenant-Colonel and Honorary Major-General on the Retired List of Our Army; Our Trusty and Well-beloved Charles Philip Cotton, Esquire; Our Trusty and Well-beloved Michael Foster, Esquire, Master of Arts, Professor of Physiology in Our University of Cambridge; Our Trusty and Well-beloved Thomas Walter Harding, Esquire, Retired Lieutenant-Colonel of Our Auxiliary Forces, with Honorary Rank of Colonel; Our Trusty and Well-beloved Thomas William Killick, Esquire; Our Trusty and Well-beloved William Ramsay, Esquire, Professor of Chemistry, University College, London; and Our Trusty and Well-beloved James Burn Russell, Esquire, Doctor of Medicine, Master of Surgery: Greeting!

Whereas We have deemed it expedient that a Commission should forthwith issue to inquire and report:

1. (1) What method or methods of treating and disposing of sewage (including any liquid from any factory, or manufacturing process) may properly be adopted, consistently with due regard for the requirements of the existing law, for the protection of the public health, and for the economical and efficient discharge of the duties of local authorities; and

   (2) If more than one method may be so adopted, by what rules, in relation to the nature or volume of sewage, or the population to be served, or other varying circumstances or requirements, should the particular method of treatment and disposal to be adopted be determined; and

2. To make any recommendations which may be deemed desirable with reference to the treatment and disposal of sewage;

Now know ye, that We, reposing great trust and confidence in your knowledge and ability, have authorised and appointed, and do by these Presents authorise and appoint, you, the said Walter Stafford, Earl of Iddesleigh, Sir Richard Thorne Thorne, Constantine Phipps Carey, Charles Philip Cotton, Michael Foster, Thomas Walter Harding, Thomas William Killick, William Ramsay, and James Burn Russell to be Our Commissioners for the purposes of the said Inquiry.

And, for the better effecting the purposes of this, Our Commission, We do by these Presents give and grant unto you, or any three or more of you,

full power to call before you such persons as you shall judge likely to afford you any information upon the subject of this Our Commission; and also to call for, have access to, and examine all such books, documents, registers, and records as may afford you the fullest information on the subject, and to inquire of and concerning the premises by all other lawful ways and means whatsoever.

And We do by these Presents authorise and empower you, or any three or more of you, to visit and personally inspect such places as you may deem it expedient so to inspect for the more effectual carrying out of the purposes aforesaid.

And We do further by these Presents will and ordain that this Our Commission shall continue in full force and virtue, and that you, Our said Commissioners, or any three or more of you, may from time to time proceed in the execution thereof, and of every matter and thing therein contained, although the same be not continued from time to time by adjournment.

And we do further ordain that you, or any three or more of you, have liberty to report your proceedings under this Our Commission from time to time, if you shall judge it expedient so to do.

And Our further will and pleasure is that you do, with as little delay as possible, report to Us under your hands and seals, or under the hands and seals of any three or more of you, your opinion upon the matters herein submitted for your consideration.

And for the purpose of aiding you in such matters, We hereby appoint Our Trusty and Well-beloved Frederick James Willis, Esquire, to be Secretary to this Our Commission.

Given at Our Court at Saint James's, the Seventh day of May, One thousand eight hundred and ninety-eight, in the Sixty-first Year of Our Reign.

By Her Majesty's Command,

(Signed) M. W. Ridley.

William Henry Power, Esq., F.R.S.,

To be a Member of the Royal Commission on Sewage Disposal.

VICTORIA, R.

Victoria, by the Grace of God, of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith: To Our Right Trusty and Well-beloved William Henry Power, Esquire, Fellow of the Royal Society, Medical Officer of the Local Government Board: Greeting!

Whereas We did, by Warrant under Our Royal Sign Manual, bearing date the Seventh day of May, One thousand eight hundred and ninety-eight, appoint Our Right Trusty and Right Well-beloved cousin Walter Stafford, Earl of Iddesleigh, Companion of Our Most Honourable Order of the Bath, together with the several Gentlemen therein mentioned, or any three or more of them, to inquire into the treatment and disposal of sewage.

And Whereas One of the Commissioners so appointed, namely, Sir Richard Thorne Thorne, has since deceased.

Now know Ye, that We, reposing great confidence in you, do, by these presents, appoint you, the said William Henry Power, to be one of Our Commissioners for the purpose aforesaid, in the room of the said Sir Richard Thorne Thorne, deceased, in addition to, and together with, the other Commissioners whom we have already appointed.

Given at our Court, at Saint James's, the Seventh day of February, One thousand nine hundred, in the Sixty-third Year of Our Reign.

By Her Majesty's Command,

(Signed) M. W. Ridley.

Whitehall, March 18th, 1901.

The King has been pleased to issue a Commission, under His Majesty's Royal Sign Manual, to the following effect:—

EDWARD, R.

Edward the Seventh, by the Grace of God, of the United Kingdom of Great Britain and Ireland King, Defender of the Faith, to all to whom these Presents shall come, Greeting!

Whereas it pleased Her late Majesty from time to time to issue Royal Commissions of Inquiry for various purposes therein specified:

And Whereas in the case of certain of these Commissions, namely, those known as—

The Historical Manuscripts Commission;
The Horse Breeding Commission;
The Local Taxation Commission;
The Port of London Commission;
The Salmon Fisheries Commission; and
The Sewage Disposal Commission;

the Commissioners appointed by Her late Majesty, or such of them as were then acting as Commissioners, were, at the late demise of the Crown, still engaged upon the business entrusted to them:

And whereas We deem it expedient that the said Commissioners should continue their labours in connection with the said inquiries notwithstanding the late demise of the Crown :

Now Know Ye, that We, reposing great trust and confidence in the zeal, discretion, and ability of the present members of each of the said Commissions, do by these Presents authorize them to continue their labours, and do hereby in every essential particular ratify and confirm the terms of the said several Commissions.

And We do further ordain that the said Commissioners do report to Us under their hands and seals, or under the hands and seals of such of their number as may be specified in the said Commissions respectively, their opinion upon the matters presented for their consideration ; and that any proceedings which they or any of them may have taken under and in pursuance of the said Commissions since the late demise of the Crown, and before the issue of these Presents shall be deemed and adjudged to have been taken under and in virtue of this Our Commission.

Given at Our Court at Saint James's, the fourth day of March, One thousand nine hundred and one, in the First Year of Our Reign.

By His Majesty's Command,

(Signed) Chas. T. Ritchie.

INTERIM REPORT.

TO THE KING'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY,

We, the Commissioners appointed to inquire and report :—

I. (1) What method or methods of treating and disposing of sewage (including any liquid from any factory or manufacturing process) may properly be adopted, consistently with due regard for the requirements of the existing law, for the protection of public health, and for the economical and efficient discharge of the duties of Local Authorities ; and

(2) If more than one method may be so adopted, by what rules, in relation to the nature or volume of sewage, or the population to be served, or other varying circumstances or requirements, should the particular method of treatment and disposal to be adopted be determined ; and

II. To make any recommendations which may be deemed desirable with reference to the treatment and disposal of sewage.

Humbly report, as follows :—

PRELIMINARY.

1. We have examined a large number of witnesses, and visited many sewage works of various kinds. We have also instituted through our own officers a number of necessary scientific investigations.

2. Many of these investigations are still in progress, and considerable time must necessarily be taken by the work which still remains to be done, and especially by such work as is needed before the second part of the Terms of Reference can be adequately dealt with.

3. We have, however, arrived at conclusions on three questions which appear, for reasons hereafter given, to be of urgent importance, and we have therefore deemed it desirable to make a preliminary report and to publish the evidence already taken.

The three questions are :—

(1) Are some sorts of land unsuitable for the purification of sewage.

(2) Is it practicable uniformly to produce by artificial processes alone an effluent which shall not putrefy, and so create a nuisance in the stream into which it is discharged.

(3) What means should be adopted for securing the better protection of our rivers.

Conclusions of previous Commissions.

4. Mr. Alfred Douglas Adrian, C.B., who, as Assistant Secretary of the Local Government Board, had charge for some years of the department concerned with questions of sewerage and sewage disposal, was the first witness whom we examined. His evidence contains a most valuable historical statement of the subject of sewage disposal, of the law on the subject, and of the practice of the Local Government Board in regard to this matter.

5. The first Sewage Commission was appointed in the year 1857. In 1865, as a result of labours extending over eight years, they reported that :— Adrian, 35.

"The right way to dispose of town sewage is to apply it continuously to land, and it is only by such application that the pollution of rivers can be avoided." Adrian, 52.

Adrian, 56. 6. In 1868, a further Commission was appointed to inquire into the best means of preventing the pollution of rivers. They made several reports, the fifth and last being made in 1874.

Adrian, 61. The opinion of this Commission on the comparative merits of the three classes of processes for the treatment of sewage, viz. :—chemical precipitation, intermittent filtration, and broad irrigation, may be stated thus :—(1) All these processes are to a great extent successful in removing polluting organic matter in suspension. But intermittent filtration is best, broad irrigation ranks next, and the chemical precipitation processes are less efficient. (2) But for removing organic matters in solution the processes of downward intermittent filtration and broad irrigation are greatly superior to upward filtration and chemical processes.

Adrian, 71. 7. The last Commission was appointed in 1882. They were directed to inquire into and report upon the system under which sewage was discharged into the Thames by the Metropolitan Board of Works, whether any evil effects resulted therefrom, and, if so, what measures could be applied for remedying or preventing the same.

Adrian, 74. In November 1884 they issued their final Report. They found that evils did exist " imperatively demanding a prompt remedy," and that by chemical precipitation a certain part of the organic matter of the sewage would be removed. They reported, however, " that the liquid so separated would not be sufficiently free from noxious matters to allow of its being discharged at the present outfalls as a permanent measure. It would require further purification, and this, according to the present state of knowledge, can only be done effectually by its application to land."

Practice of Local Government Board.

Adrian, 107. 8. Since the publication of the last-mentioned Report it has been the practice of the Local Government Board to require, save in exceptional cases, that " any scheme of sewage disposal, for which money is to be borrowed with their sanction, should provide for the application of the sewage or effluent to an adequate area of suitable land before its discharge into a stream." There can be no doubt, in our opinion, that the Local Government Board were bound, under the circumstances, to insist upon such a rule.

Reasons for Reconsidering Position.

Tatton, 261, 284, 402–4, 6632. Naylor, 931. Barwise, 4028. Maclean Wilson, 6138–9. 9. It is now contended that in many cases, especially in the great centres of manufacturing industry, the land available is either of unsuitable quality, is available in quite inadequate area for effective filtration through the soil, or is obtainable only at a prohibitive cost, and it is suggested that sewage purification may, in such cases, be carried out on comparatively small areas artificially prepared. During recent years a variety of artificial processes, differing from those which were considered by the earlier Commissions, have been elaborated for treating sewage, and it is urged that satisfactory effluents can be obtained by such artificial processes.

Scope of Work of this Commission.

10. Having regard to the definite findings of previous Commissions, to the consequent practice of the Local Government Board in insisting on the provision of land for the purification of sewage, and to the fact that the artificial processes are still only in the experimental stage and, as might be expected therefore, the evidence in regard to them is inconclusive on many points, it has appeared to us essential to subject the artificial processes to sustained examination, and also carefully to test the contention that in certain cases it is not practicable to purify sewage by land treatment.

11. At the time of the investigations of the earlier Commissions, the science of bacteriology was in its infancy, and these Commissions confined themselves almost entirely to a chemical examination of sewage effluents. Since the dates of those Commissions a large amount of exact knowledge has been gained concerning the part played by bacteria in various processes of nature and operations of man, and it became our duty to study the various questions connected with sewage disposal, not

only from a chemical but from a bacteriological point of view as well. This has largely increased our labours, but we trust will also largely increase their usefulness. We have had to initiate and carry out various bacteriological investigations, and, in particular, finding that the work done by earlier Commissions in regard to land treatment was not complete enough for our purposes, we have thought it necessary to include in our work a systematic investigation, bacteriological as well as chemical, of the treatment of sewage on land of various kinds. This investigation is on the point of completion.

12. For the purpose of our own work we appointed the following officers :— Officers appointed.

Professor Boyce, Bacteriologist.
Dr. Houston, Bacteriologist.
Dr. McGowan, Chemist.
Mr. Colin Frye, Chemist.
Mr. G. B. Kershaw, Engineer.

Question I. :—Are some sorts of Land Unsuitable for the Purification of Sewage.

13. As regards the allegations that certain sorts of land are so unsuitable as to render them practically useless for the purification of sewage, we have received evidence from a number of witnesses who have had much experience of sewage treatment. Almost without exception their testimony is to the effect that peat and stiff clay lands are unsuitable for the purification of sewage. Conclusions as to certain sorts of land.

14. Our own officers have made a large number of analyses of effluents from well-managed farms with different classes of soil, and their results support this general opinion.

CONCLUSION 1.

15. We doubt if any land is entirely useless, but in the case of stiff clay and peat lands the power to purify sewage seems to depend on the depth of the top soil.

There are, of course, numerous gradations in the depths of top soil which are met with in nature, and it is not easy to draw the line between lands which contain a sufficient depth to justify their use, and lands which do not.

We are, however, forced to conclude that peat and stiff clay lands are generally unsuitable for the purification of sewage, that their use for this purpose is always attended with difficulty, and that where the depth of top soil is very small, say six inches or less, the area of such lands which would be required for efficient purification would in certain cases be so great as to render land treatment impracticable.

Further information with regard to this point will be available when our investigation of Land Treatment is completed.

Question II. :—Is it practicable uniformly to Produce by Artificial Processes alone an Effluent which shall not Putrefy and so Create a Nuisance in the Stream into which it is Discharged.

16. The following general classification will serve to show the nature of the artificial processes to which we refer :— Purification obtainable by artificial processes.

Closed septic tank and contact beds.
Open septic tank and contact beds.
*Chemical treatment, subsidence tanks, and contact beds.
Subsidence tanks and contact beds.
Contact beds alone.
Closed septic tank followed by continuous filtration.
Open septic tank followed by continuous filtration.
Chemical treatment, subsidence tanks, and continuous filtration.
Subsidence tanks followed by continuous filtration.
Continuous filtration alone.

---

* The expression "subsidence tanks" is intended to denote tanks which are used in such way that little or no "septic" action is produced.

17. Many valuable experiments on artificial treatment have been made by a number of local authorities, and in particular the Corporations of Leeds and Manchester have subjected certain processes to sustained observation. In this way much reliable information has been obtained.

18. We are not, however, in a position to express an opinion upon the relative merits of the several artificial processes, nor can we at present make a complete comparison between land treatment and artificial treatment of sewage, or state how far purification of sewage can be uniformly effected by one or another artificial process, and at what cost as compared with land treatment.

The character of the sewage of different towns varies to a considerable extent, especially in respect to the amount and nature of the trade refuse mixed with the domestic sewage, but also in respect to domestic sewage itself; and a method applicable to one sewage might not be applicable to another. The problems involved in the matter are so many and so varied that only investigation, and, we may add, experience of a prolonged and varied character, will suffice to solve them.

CONCLUSION 2.

19. After carefully considering, however, the whole of the evidence, together with the results of our own work, we are satisfied that it is practicable to produce by artificial processes alone either from sewage, or from certain mixtures of sewage and trade refuse such, for example, as are met with at Leeds and Manchester, effluents which will not putrefy, which would be classed as good according to ordinary chemical standards, and which might be discharged into a stream without fear of creating a nuisance.

We think, therefore, that there are cases in which the Local Government Board would be justified in modifying, under proper safeguards, the present rule as regards the application of sewage to land.

No general rule as to what these safeguards should be can be laid down at present, and indeed it will, probably, always be necessary that each case should be considered on its own merits.

Bacteriological Qualities of Effluents. Sewage Effluents in Relation to Disease.

20. As we have already said sewage effluents must, in accordance with present knowledge, be judged not only from a chemical but also from a bacteriological point of view. In order to safeguard public health, it is, in certain cases at any rate, not enough to know the chemical features of an effluent and to ascertain that it will not putrefy of itself, we must know the bacteriological features as well.

Thomson, 1392. Adeney, 2445–6. Marshall Ward, 2653–5; 2727–2748. Woodhead, 2988. Frankland 3043–8. Roscoe, 3653–5; 3662. Barwise, 4041. Rideal, 4406. Thresh, 8956–7.

21. Several witnesses have referred to the danger of allowing pathogenic organisms to enter streams which are used for drinking purposes, and our own officers are carrying out careful prolonged investigations on this matter.

We are impressed with the great importance of the bacteriological questions which have arisen in the course of our Inquiry, but we do not, at present, feel justified in putting forward any conclusions concerning them.

We may, however, even at this stage point out, that as a result of a large number of examinations of effluents from sewage farms and from artificial processes we find that while in the case of effluents from land of a kind suitable for the purification of sewage there are fewer micro-organisms than in the effluents from most artificial processes, yet both classes of effluents usually contain large numbers of organisms, many of which appear to be of intestinal derivation, and some of which are of a kind liable, under certain circumstances at least, to give rise to disease.

We are of opinion, therefore, that such effluents must be regarded as potentially dangerous, and we are considering whether means are available and practicable for eliminating or destroying such organisms, or, at least, those giving rise to infectious diseases.

Question III. :—What means should be adopted for securing the better Protection of our Rivers.

22. From the evidence which we have received, from our own observation, and from information collected for us by the Local Government Board for Scotland, we are satisfied that the Rivers Pollution Prevention Act, 1876, has not resulted in the general purification of our rivers. Protection of rivers. Curphey 1822. Frankland, 3010.

23. This is due largely to the reluctance of the authorities to put the Act in force, but partly also to the difficulty which a sanitary authority experiences in proving that the pollution within its district comes from the district against which, or the person against whom, action is taken. An authority wishing uniformly to enforce the Act in its own district has no security that the authorities above and below it on the stream will do the same, and it is therefore naturally disinclined to take action. Tatton, 254. Curphey 1808; 1825–6. Roscoe, 3768.

24. The Local Government Act, 1888, Section 14 (1) and the Local Government (Scotland) Act, 1889, Section 55 (1), give to County Councils of England and Wales and Scotland "power in addition to any other authority to enforce the provisions of the Rivers Pollution Prevention Act, 1876, in relation to so much of any stream as is situate within or passes through or by any part of their county."

25. This concurrent power of the County Council does away with the difficulty of proving pollution within a district from a source within the area of the county, though outside the district, and it should insure equal and fair treatment for all authorities and persons within the county. Several county councils are putting the Act into operation and are making good progress.

26. Section 14 (3) of the Act of 1888 provides that "The Local Government Board by Provisional Order made on the application of the council of any of the counties concerned may constitute a Joint Committee or other body representing all the administrative counties through or by which a river, or any specified portion of a river, or any tributary thereof passes, and may confer on such committee or body all the powers of a sanitary authority under the Rivers Pollution Prevention Act, 1876, or such of them as may be specified in the Order," and similar powers are conferred on the Secretary for Scotland by Section 55 (3) of the Local Government (Scotland) Act, 1889.

27. Under the Local Government Act, 1888, the Mersey and Irwell Joint Committee, the Ribble Joint Committee, and the West Riding Rivers Board have been constituted. The evidence shows that these bodies have done much useful work in enforcing the treatment of sewage and trade refuse, and that it is of considerable importance to have for each watershed a single authority. Tatton, 256. Scudder, 497; 6149. Naylor, 845. Maclean Wilson, 1175–6. Roscoe, 3554. Hibbert, 7885–7.

The advantages a county has in enforcing the Rivers Pollution Prevention Act, 1876, are also possessed by a Joint Committee of more than one county, and are increased in proportion to the wider area.

28. But those councils or committees of more than one county who are enforcing the Act feel the injustice of compelling their authorities and manufacturers to purify their effluents, whilst in other parts of the country and over wide areas little or nothing is being done. Tatton, 273.

29. Previous Commissions have referred to the necessity of setting up watershed boards, and otherwise strengthening the machinery for the protection of our rivers, as the following extracts will show :—

Extracts from Second Report of the Commission appointed in 1857 to inquire into the best mode of distributing the sewage of towns.

"We have now to urge, as the first and all-important step towards securing this object and the "permanent improvement and protection of the rivers of the country, that a general local jurisdiction and "conservancy be created throughout the kingdom, with adequate powers and proper guarantees for their "due administration." Page 9.

* * * * * *

"The abuses and nuisances which have now grown up with the growth of towns and manufactures "urgently demand some available law for the conservancy of rivers, from their sources to their outfalls."

* * * * * *

Page 40. "Having now fully stated our conclusions as to the means of disposing of the sewage of towns, and "shown that the remedies for the evils which are experienced, although various, are both practicable and "economical, we beg to repeat our conviction that the only security for a general and continued employment "of such means will be the establishment of responsible conservancies throughout the country, armed with "adequate powers."

EXTRACTS from First Report of the Commissioners appointed in 1865 to inquire into the best means of preventing the Pollution of Rivers.

Page 32. "We also humbly submit the following Recommendations to Your Majesty :—

"That the whole river be placed under the superintendence of one governing body."

"That it be made incumbent upon the Conservators to see to the enforcement of the above prohibitions "against pollution of the river. . . ."

EXTRACTS from Third Report of the Commissioners appointed in 1865 to inquire into the best means of preventing the Pollution of Rivers.

Page 53. "Where manufactures have been established and a large resident population has grown up as before "stated, the greatest amount of pollution takes place, the area of country over which such form of nuisance "is spread having no defined boundary other than the dividing ridges of such watershed and the shores of "the sea. In order to prevent the Pollution and legally control the Management of rivers, their basins or "watersheds must be placed under supervision, irrespective of any arbitrary divisions of County, Parish, "Township, Parliamentary, Municipal, or Local Government Act boundaries; or, indeed, of any artificially "established division. Running waters flow on from their source to the sea, and if the upland waters are "polluted by town sewage and by refuse discharged from manufactures, as in the West Riding of Yorkshire, "the entire length of a river is necessarily polluted, and will require to be Conserved or protected."

Page 54. "One conclusion, therefore, forces itself upon anyone who honestly deliberates upon the existing state "of things in regard to the rivers we have visited with a view to its permanent improvement. A stronger "power than has hitherto been available must be brought to bear if the present abuse and pollution of "streams is to be arrested, and Government supervision and inspection must enforce and strengthen the "action of local authorities."

EXTRACT from First Report of the Commissioners appointed in 1868 to inquire into the best means of Preventing the Pollution of Rivers.

Separate Conclusions and Recommendations by Major-General Sir William Denison, K.C.B., *Chairman.*

Page 132. "The evidence we have had of the total disregard of mere legal enactments which tend to fetter the "actions of masses of people, of the constant evasions of obligations imposed by law, of the inefficiency of the "law, even when means have been found to bring it into action, to enforce the adoption of any special "remedy for the evils complained of, has satisfied me that it will be necessary to call into action an authority "superior to all those local municipalities, embracing in its scope the whole area of the watershed subdivided "among these bodies, and to confer upon such authority powers differing both in kind and degree from that "exercised by ordinary municipalities or conservancies."

EXTRACT from Third Report of the Commissioners appointed in 1868 to inquire into the best means of Preventing the Pollution of Rivers.

"RECOMMENDATIONS."

Page 56. "3. That all rivers and streams in England be placed under the superintendence of a central authority "or board, to be composed of not more than three persons, who shall be duly qualified to deal with all questions "connected with the pollution of water and with water supply.

"4. That it be the duty of this board to see that all enactments relating to the use or abuse of running "water be duly enforced; and that for this purpose power be given to it to inspect manufactories; reservoirs, "sewerage, and other similar works; and to cause to be constructed, at the expense of the owners of the "same, whether corporate or private, any necessary purifying apparatus, in case the said owners neglect or "refuse to provide such apparatus for themselves."

CONCLUSION 3.

30. We consider it of the utmost importance that the simplest possible means should be provided for adequately protecting all our rivers, and we are further of opinion that it will be desirable, probably for some time to come, that scientific experiments should be carried on in order to ascertain all the real dangers of pollution, against which they should be protected.

In the present state of knowledge, and especially of bacteriology, it is difficult to estimate these dangers with any accuracy, and it seems quite possible that they should be either exaggerated or undervalued according to the predisposition of those who have to deal with them. An authority, guided by medical considerations, might not unnaturally be inclined to insist on a degree of purity which may ultimately prove in certain cases to be uncalled for, while another authority, with its mind fixed upon economy, might shrink from taking essential precautions.

31. It is, perhaps, scarcely for us to say what arrangements should be made, but we are of opinion that the general protection of our rivers is a matter of such grave concern as to demand the creation of a separate commission, or a new department of the Local Government Board, which shall be a Supreme Rivers Authority, dealing with matters relating to rivers and their purification, and which, when appeal is made to them, shall have power to take action in cases where the local authorities have failed to do so.

32. We cannot conclude this Report without referring to the very serious loss which we sustained by the death of Sir Richard Thorne Thorne at a comparatively early stage of our Inquiry. He was a most active member of the Commission, and his advice and help were invaluable.

(Signed) IDDESLEIGH.
C. PHIPPS CAREY.
CHARLES P. COTTON.
M. FOSTER.
T. WALTER HARDING.
T. W. KILLICK.
WILLIAM RAMSAY.
JAS. B. RUSSELL.
W. H. POWER.

F. J. Willis, Secretary,
12th July 1901.

ROYAL COMMISSION ON SEWAGE DISPOSAL 1902 - 1915

(FIRST) INTERIM REPORT - Volume II missing

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VOL. III.

APPENDICES.

Presented to both Houses of Parliament by Command of His Majesty.

LONDON:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE,
BY WYMAN AND SONS, LIMITED, FETTER LANE, E.C.

And to be purchased, either directly or through any Bookseller, from
EYRE AND SPOTTISWOODE, EAST HARDING STREET, FLEET STREET, E.C., and
32, ABINGDON STREET, WESTMINSTER, S.W.; or
OLIVER AND BOYD, EDINBURGH; or
E. PONSONBY, 116, GRAFTON STREET, DUBLIN.

1902.

[Cd. 686—I.] *Price* 14*s.* 9*d.*

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5810. Wt. 5470. 1000—2/02. Wy. & S.

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APPENDIX No. 1.

Handed in by Mr. R. A. Tatton, M.I.C.E.

REPORT to the Mersey and Irwell Joint Committee on the Treatment of Manufacturers' Waste Waters. By R. A. Tatton, M.I.C.E., Chief Inspector.

44, Mosley Street, Manchester.

To the Chairman and Members of the Joint Committee.

Gentlemen,

In accordance with your instructions, I beg to lay before you the following report on the general question of the treatment of manufacturers' waste waters :—

A Royal Commission was, as you are aware, appointed in the year 1868 to inquire into the whole question, and their report, which is very voluminous, is of the greatest importance. Another report, made by the late Dr. Angus Smith to the Local Government Board on the Rivers Pollution Prevention Act 1876, should also be brought to your notice ; it gives general rules for the treatment and precipitation of effluents from printworks, dyeworks, paper-works, etc., with particulars as to the chemicals used and the results obtained. This report is of great value. Although the exact process may require modification in different cases, it gives general lines to work upon, and, moreover, demonstrates what can be done.

The third report is that of Sir Henry Roscoe, which forms the basis on which the work of the Joint Committee has been proceeding. General rules are given for the guidance of the manufacturers, but the question of what chemicals are to be used for effecting the precipitation and subsidence which is recommended is necessarily left for each individual manufacturer to investigate for himself. Sir Henry gives as his opinion that "the best practical means for preventing pollution must be adopted."

I think the readiest way of dealing with the subject will be to give that part of Dr. Angus Smith's report which deals with effluents from printworks, dyeworks, paper-works, etc., *in extenso*, as an Appendix, referring to it from time to time as it particularly affects the different works dealt with.

Paper-works.—The question of pollution from paper-mills is dealt with in the first and fourth reports of the Commissioners. A full description is given of the process, which does not differ materially from that of the present day.

The different kinds of refuse are divided into four heads :—

1. The product from the dusting process.
2. The lime refuse from the treatment of the soda to make it caustic.
3. The alkaline waste liquor.
4. The insoluble part of the bleaching powder.

The first refuse is solid, and valuable as manure, and there is no excuse for throwing it into the river.

The second refuse, which is also valuable as manure, can be drained in pits, or it may be pressed and carted away. The same remark applies to the fourth refuse.

The third refuse the Commissioners report to be at once a source of injury, the most serious and the most difficult to meet. It consists of the alkali liquor in which the straw, esparto grass, rags, or whatever material is used in the preparation of the paper, has been boiled, and also of the water in which the material is subsequently washed. The first part of this liquor—namely, that from the boilers—is very foul ; but in cases where a large quantity of soda ash is used (as with esparto grass), evaporators may with advantage be put down, as the quantity of soda ash saved is said to pay for their erection. The remainder of the alkali liquor which comes from the washing machines (also that from the boilers if evaporators are not in use) must be treated differently, and the Commissioners report in favour of land filtration.

Since the date of the Commissioners' report, however, great progress has been made in the reduction of pollution, especially at the paper-works on the North Esk, where, in consequence of litigation with the landowners lower down the river, means for rendering the waste waters innocuous have been brought to greater perfection than perhaps anywhere else in the country. The improvements in this respect have been carried out in the manufacture of the paper itself by retaining more of the fibre, and therefore allowing less to go down the river. It is satisfactory to find that the restrictions have been the cause of a distinct saving in material to the manufacturer, all the fibre which is allowed to escape being loss to him. The most important improvement is effected by washing the esparto grass in a series of tanks after it has left the boilers, and before it goes to the ordinary washing machines. The water used in these tanks flows from one to another, and the arrangement is such that supposing the series to consist of 10 tanks each boiling of grass receives ten washings, the pure water being turned in the first instance on to the boiling, which has already been washed nine times, and finishing with the boiling which has been last brought from the boiler ; the water is then used in the boiler itself, and is finally taken to the evaporator. This system not only largely reduces the polluton by removing most of the alkali liquor before the grass goes to the ordinary washing machines, but also saves a considerable percentage of fibre. It should certainly be adopted at all mills where esparto grass and straw are used. Appendix I.

With regard to the settling tanks used on the Esk, they also show a great improvement both in economy and efficiency over the tanks in this district. All the waters not treated in the evaporators flow to the tanks, which in the most efficient systems are arranged as a series of shallow channels, 40 feet long and 2 feet in width ; the water flows over sills at each end of the channels, which must be of sufficient area to keep the water as quiescent as possible. The sludge from these tanks is dried, and if consisting of fibrous matter only, as from rag washings or from the machines, it may be sold for making inferior kinds of paper, thus making the tanks remunerative. The effluent water is finally passed through cinder filters 18 inches in depth, and care must be taken that it is either neutral or slightly acid before getting into the river.

Dr. Angus Smith's report (*see* Appendix) gives the results obtained by treating the effluent with chemicals. The precipitation takes place quicker, and consequently the tanks need not be so large ; also the treatment is more likely to be efficient without filtration, which is apt to be a troublesome process.

To summarise, I would suggest that all paper-makers who use esparto or straw in any quantity should erect evaporators and washing tanks such as I have described, and that the whole of the remainder of the waste waters should be treated in settling tanks. It might be misleading to give a minute description of the settling tanks, as different works will necessarily vary in their requirements ; but any system adopted should be planned with a view to the sludge being remunerative.

Printworks and Dyeworks.—The pollution from this class of works is caused by aniline dyes, logwood, and other wood extracts, soap, starch, fustic, soda, bleaching powder, &c. All waste waters which contain these must be treated, with the exception of the wash waters, in which the polluting matter is so small in comparison to the quantity of water used that unless unusually foul they may safely be allowed to go into the river.

In certain cases no doubt there will be a difficulty in separating the wash waters from the dye and more pol-

luted waters, and some manufacturers may find it more economical to treat the whole than to lay down a second system of drains.

For the treatment of these waste waters the Royal Commission recommend filtration through land; but as land in sufficient quantity is in most cases difficult to obtain, I think we must look to chemical precipitation, with or without subsequent filtration through artificial filters, as the process to be adopted.

One of the most efficient purification systems in the watershed consists of three brick tanks and a filter. The tanks are so arranged that the waste water can be turned through all three tanks in succession, in which case there is a constant though slow flow, or it can be turned into a single tank, allowing the other two to remain quiescent for the solid matter to precipitate. After issuing from the tanks, the effluent is passed through the filter. The filtering material used is cinders, which have been found more efficient than sand; but I think that if the sand used was of a good, sharp quality it would give better results than cinders, and be more easy to clean.

The precipitant used is put into the channel which conducts the waste water from the works to the tank, so that the whole is thoroughly mixed together before its arrival at the tank. This mixing is of the greatest importance, and on it depends the efficient action of the precipitant. It may be aided by bafflers or boards placed in the channel, to cause disturbance of the stream.

A convenient way of applying the precipitant is to have it in solution in a cask, with a tap arranged to discharge into the channel. The tap can be regulated to give the required quantity.

The effluent from the tanks is drawn off by floating valves which admit the surface water only, and which must not be allowed to sink below the depth of the clear water. The sludge below this depth must be either pumped out or run through valves in the bottom of the tank into a sludge well. Neither from the sludge well nor from these valves in the bottom must there be any communication with the river.

I have purposely given no details as to size of tanks, as such information may be misleading, but as a general rule a good system should consist in the first place of a large tank or pit containing a day's supply; into this tank the whole of the waste waters from the works should be run, "when," as pointed out by Dr. Angus Smith, "large precipitates occur, and frequently complete neutralisation arising from this—namely, that the processes have required equivalent amounts of acid and alkali, although they escape separately."

From this tank the effluent must pass by means of a channel to the precipitation tanks, and the precipitant used must be put into this channel.

The precipitation tanks should be at least two in number, and arranged to be used alternately. They should each contain half a day's supply, and be fitted either with floating valves or some other means of drawing off the clear water. The sludge may be pumped from the tanks direct, or, what is better, drawn off into a sludge-well, which will enable the tank to be got to work again quicker. What precipitant is best to use each manufacturer must decide for himself; but Dr. Angus Smith's report (*see* Appendix) gives a number of experiments, and shows what results can be obtained —in one case 99·8 per cent. of colour being removed.

Several patent processes have been brought out which deal with these waste waters in considerably less space than is required for the ordinary method; manufacturers who have not room for large tanks should consider the advisability of adopting one or other of them.

Bleachworks.—The waste waters from bleachworks vary considerably according to the class of goods dealt with.

The waste bleacher's refuse is the worst, as a large amount of oil and dirt comes away from the goods, in addition to the lime, soda, etc., used in the process. The water from the keirs in which the pieces of yarn are boiled should in all cases be treated, also all solid lime refuse must be kept out of the river; the wash waters may, as a rule, be allowed to go direct into the river except in certain cases (including waste bleaching), when part of them will require treatment. These should be concentrated as much as possible, in order to reduce the quantity.

Precipitation in tanks is probably the best treatment, as the subsidence of the solid matter is assisted by the large amount of lime in the water. The most successful system I know of in operation consists of a succession of large pools, through which the water slowly flows; it is finally passed through a cinder filter before being admitted into the river. No additional precipitant is used, but I think it probable that if one were adopted a great improvement would be the result, and the size of the tanks could be considerly reduced.

Woollen Works and Fullers.—The waste waters from these works are very offensive, and in some parts of the watershed are responsible for most of the pollution. They contain animal oils from the wool, soap, soda, and fuller's earth. These may be readily dealt with by means of precipitation and filtration, as has been proved at several works where a purification plant has been put down. The most efficient system in the watershed consists of two settling tanks, three precipitation tanks, and one sand filter. The settling tanks, which are made from two old boilers, retain most of the heavy matter and fuller's earth, and considerably relieve the precipitation tanks through which the waste water flows next; these tanks are used alternately to allow of those not in use being cleaned out. The sand filter completes the treatment. Alumino ferric is the precipitant used, and is introduced into the channel leading to the settling tanks. Another firm has lately been experimenting with sulphate of iron and lime with good results.

Sap-pits for the recovery of the soap, which have been almost universally adopted, can be used in conjunction with a system similar to the above.

Dr. Angus Smith gives a large number of experiments with various precipitants, particulars of which will be found in the Appendix.

The Royal Commissioners in their report recommend application to land, either by irrigation or intermittent filtration, as the best means of dealing with these liquids. This plan might well be adopted where land can be obtained in sufficient quantity and of suitable character, or land might be used instead of the sand filter after the water has passed through the precipitation tanks.

Very efficient plant has been erected at the woollen mills at Galashiels, and the effluent obtained is good enough, in the estimation of Mr. Fletcher (Inspector under the Rivers Pollution Act), to entitle the manufacturers to a certificate under the Act. The waste water is very foul—the impurities consisting of soap, animal grease, and dyes—the result of every stage of manufacture from the fleece to the finished cloth. The different waters are purified by precipitation in tanks—lime being used with the dye and acid with the soap liquors; the two being finally mixed together and further neutralised if necessary before being admitted into the river. The precipitation of the solids is aided by the introduction of air forced through perforated pipes into the tanks. One man is continuously employed attending to the tanks and pipes, etc., connected with them. This system is probably the most efficient in the country, and has been universally adopted on the River Gala, the water of which must previously have been seriously polluted.

Silkworks.—The chief pollution from these works is caused by the gum, which is removed from the raw silk by washing in a solution of soap. The waste may be treated by processes well known to the silk manufacturers. The dye-water will require treating in the same manner as from print and dye-works.

Chemical Works.—The waste waters from this class of works are so various that it is impossible to lay down any general rules for their treatment, as stated in Sir Henry Roscoe's report. Each case will require to be taken separately, the composition of the effluent water ascertained, and if inadmissible either into the river or sewers, some means of chemical treatment adopted. It might perhaps be possible to have a schedule drawn up, showing how the usual products which are run to waste may be dealt with, and whether they are admissible into the river or sewers.

Breweries.—The washings of barrels, fermenting vats, and cooling tanks make up the waste waters from these works. The refuse is of a very obnoxious character, and seriously pollutes any stream into which it is discharged. It should be precipitated in tanks, and subsequent filtration would probably be attended with good results.

Tanneries and Fellmongers.—The waste waters from these works are most offensive, and must be rigorously excluded from the streams. The readiest means of dealing with them, after passing them through tanks to intercept the bulk of the solid matter, is to admit them into the sewers. The quantity of water used is not large. If there are no sewers near the works, some treatment must be adopted; probably a treatment similar to one of those adopted at sewage works would prove the most efficient. One manufacturer has put down a precipitation tank and filter which does its work fairly efficiently.

Slack Washing is a process employed at some collieries for separating small coal, which would otherwise be of little value, from the refuse with which it is mixed when brought up from the pit. The effluent water contains a large amount of solid matter in suspension; it may readily be treated by passing it through settling tanks, which should be put down at all collieries where this process is used.

I have endeavoured to put before your Committee a description of the various kinds of pollution, and the best available methods of dealing with them. It has not been possible within the compass of this report to go into great detail, nor is it requisite to do so. General rules only can be given, which must be adopted to the requirements of each individual works. Any further information which we have or can obtain is at the service of anyone desiring it.

I am, etc.,

R. A. Tatton.

February 16th, 1893.

APPENDIX.

Extract from report of Dr. Angus Smith to the Local Government Board.

Effluents from Printworks, Dyeworks, etc.
Precipitation.—General Rules.

If the effluents from dyeworks or printworks are alkaline, containing organic substances coloured or otherwise, an acid generally throws down a decided amount of solid matter. If the effluent contains soap, the fatty matters are separated, and fall or rise to the surface. These fatty matters may contain a large amount of colouring matter which may or may not be of value.

If acid is expensive at the place of precipitation a similar result can be obtained by chloride of calcium or any cheap metallic or earthy salt. Chloride of calcium is the simplest, and has a great influence. Its effect is not limited to the soap, but is observed in the effluents from paper-works, and other cases where the liquids are alkaline.

Salts of calcium are, therefore, very valuable; and as they are found at bleachworks, printworks, and paper-works, and wherever bleaching is done, they have a great influence on the discharges. This influence is not always seen at once; it requires some time, and it would appear as if settling tanks were absolutely necessary. It would be very good if we could hasten this precipitation. To some extent this is done by adding metallic or aluminous salts, but it is done also by stirring or shaking, as we often find in a laboratory, and previous to allowing the solution to rest. Thinking of this, one would have supposed that very violent action would have assisted still more the fall; but this was not the case. We found that by agitating the effluents after mixture with the precipitant, these could be reduced to a state of division so fine as to delay their fall.

The advantages of chloride of calcium are that it is frequently a waste product, and a great deal could be obtained if it were wanted.

Lime will certainly throw down the fatty matter of soap, and it will also take a great deal of solid matter out of the effluents of paper and other works but it will not neutralise in such cases; on the contrary, it causticises these liquids. Chloride of calcium also can be thrown in considerable quantities into a river without injury, whereas this is not the case with lime.

The first thing to be done with the effluents from works generally is to allow them all to mix together, when large precipitates occur, and frequently complete neutralisation, arising from this, namely, that the processes have required equivalent amounts of acid and alkaline, although they escape separately. Cases exist, however, in which such a mixture would be of no advantage; and in other cases, as in alkali works, the mixture of the acid and sulphide liquors produces intolerable results.

The works, however, specially under consideration give out liquids which by this treatment cause considerable and sometimes large precipitates. The addition of chloride of calcium causes a second precipitate frequently, and it may be that this will be in some cases a sufficient treatment.

When better results are required, it is apparently essential to use salts of iron or aluminum; and few waters from these works under consideration will not become clear after this treatment; most, if not all, can be made also nearly colourless.

It would be quite wearisome to detail all the experiments made to come to these conclusions, but various results will be here given, and they may be compared also with those from sewage treatment.

Effluents from Paper Works.—May, 1878.

Discharge Water from Settling Ponds, Carron Grove Works.—19th April, 1878.

(1.) After filtration,—
10 lbs. Alum, 2·5 lbs. Lime } per 1,000 galls.
Volatile = 4·9 gr. per gall.
Mineral = 65·94 ,,
Total = 70·84 ,,
The filtrate was slightly acid; colour = 0·1 c. c. NH_4Cl with Nessler. No permanent froth on shaking.

(2.) After filtration,—
8 lbs. Alum, 2·5 lbs. Lime } per 1,000 galls.
Volatile = 5·67 gr. per gall.
Mineral = 57·33 ,,
Total = 63·00 ,,
The filtrate was faintly alkaline; colour = 0·4 c. c. NH_4Cl with Nessler. No permanent froth on shaking.

(3.) After filtration,—
4 lbs. Alum, 2·5 lbs. Lime } per 1,000 galls.
The filtrate decidedly coloured. Permanent froth on shaking.

Sample received 29th April, 1878.

(4.) After filtration,—
10 lbs. Alum, 2·5 lbs. Lime } per 1,000 galls.
Volatile = 0·28 gr. per gall.
Mineral = 76·16 ,,
Total = 76·44 ,,
Similar to No. 1.

(5.) After filtration,—
8 lbs. Alum, 2·5 lbs. Lime } per 1,000 galls.
Volatile = 11·48 gr. per gall.
Mineral = 77·55 ,,
Total = 89·04 ,,
Similar to No. 2 as to froth. Filtrate slightly coloured.

(6.) After filtration,—
6 lbs. Alum, 2·5 lbs. Lime } per 1,000 galls.
Filtrate decidedly coloured. Froth lingered slightly.

Sample received 19th April, 1878.

(7.) After filtration,—
2·5 lbs. $Fe_2(SO_4)_3$, per sulphate of iron. Lime quant. suff. } The lime was added immediately after the iron sol. Filtrate slightly coloured.

(8.) After filtration,—
1·25 lbs. $Fe_2(SO_4)_3$, Lime quant. suff. } The lime was added five minutes after the iron sol. Filtrate was colourless.

(9.) After filtration,—
0·7 lb. $Fe_2(SO_4)_3$, excess powdered chalk } The ppt. settled readily. Filtrate clear; did not froth.

Clarification of Logwood Waste Liquors.—March, 1879.

Exit Liquor from Works.

(1.)	100 lbs. Alum Cake, 7·5 lbs. Lime	per 1,000 galls.	Colour almost gone.
(2.)	20 lbs. Alum Cake, 1·5 lb. Lime	per 1,000 galls.	97 % colour removed.
(3.)	10 lbs. Alum Cake, 0·76 lb. Lime	per 1,000 galls.	95 % colour removed.
(4.)	6 lbs. Alum Cake, 0·76 lb. Lime	per 1,000 galls.	90 % colour removed.
(5.)	4·74 lbs. Ferric Chloride, 6·00 lbs. Lime	per 1,000 galls.	99·8 % colour removed.
(6.)	2·16 lbs. Ferric Chloride, 4·56 lbs. Lime	per 1,000 galls.	98 % colour removed.
(7.)	0·66 lb. Ferric Chloride, 2·28 lbs. Lime	per 1,000 galls.	70 % colour removed.

Note.—There was a little free HCl along with the Fe_2Cl_6, ferric chloride or perchloride of iron.

(8.) 18·5 lbs. hydrated alumnia per 1,000 galls. 60 % colour removed.

(9.) 4·12 lbs. Fe_2Cl_6, 12·5 lbs. HCl, 5·0 lbs. Lime } per 1,000 galls. Colour destroyed. The ppt. settles rapidly and perfectly.

(10.) 2·1 lbs. Fe_2Cl_6, 6·25 lbs. HCl, 2·5 lbs. Lime } per 1,000 galls. Colour destroyed. The ppt settles rapidly and perfectly.

(11.) 1·25 lbs. Fe_2Cl_6, 2 lbs. Lime, 3·75 HCl } per 1,000 galls. Filtrate faintly coloured. Ppt. settled fairly, but left a turbidity in the liquid, which, however, was readily removed by filtration.

(12.) 0·85 lbs. Fe_2Cl_6, 2·5 lbs. HCl, 1·5 lbs. Lime } The ppt. behaved as in No. 11, but the filtrate was distinctly coloured.

(13.) 200 lbs. $CaCl_2$, chloride of calcium, per 1,000 galls. removed 60 % of the colour.

Appendix I

Clarification of Liquors from Woollen Mill.

Contents of last Tank before entering "Lade," Copperas, or protosulphate of iron, or ferrous sulphate.

(a.)	8 lbs. Ferrous Sulphate 0·5 lbs. Lime	per 1,000 galls.	66 % colour removed.
(b.)	8 lbs. Ferrous Sulphate	per 1,000 galls.	39·3 % colour removed.
(c.)	12 lbs. Ferrous Sulphate 0·5 lbs. Lime	per 1,000 galls.	84·5 % colour removed.
(d.)	12 lbs. Ferrous Sulphate	per 1,000 galls.	78·7 % colour removed.
(e.)	2·6 lbs. Fe_2Cl_6 (?) Lime	per 1,000 galls.	89·4 % colour removed.
(f.)	8 lbs. Alum 0·5 lb. Lime	per 1,000 galls.	71 % colour removed.
(g.)	8 lbs. Alum	per 1,000 galls.	72·5 % colour removed.
(h.)	6·5 lbs. Fe_2Cl_6 5·6 lbs. Lime	per 1,000 gals.	95·6 % colour removed.

(i.) No. (h) with 8 lbs. Copperas per 1,000 galls. 98·9 % colour removed. The ferrous salt was added to destroy the chromate which was left by the ferric salt.

(j.)	3·7 lbs. Fe_2Cl_6 8·0 lbs. Copperas 2·75 lbs. Lime	per 1,000 galls.	96·5 % colour removed.
(k.)	3·7 lbs. Fe_2Cl_6 20 lbs. Copperas 2·75 lbs. Lime	per 1,000 galls.	97 % colour removed.
(l.)	7·4 lbs. Fe_2Cl_6 4·0 lbs. Copperas 5·5 lbs. Lime	per 1,000 galls.	96·5 % colour removed.
(m.)	3·7 lbs. Fe_2Cl_6 2·75 lbs. Lime	per 1,000 galls.	92 % colour removed.

(n) No. (m) with 8 lbs. $FeSO_4 . 7 H_2O$ per 1,000 gals. No further change. Comp. (h) and (i).

(o) No. (n) with 1·4 lbs. Lime per 1,000 galls. 98·2 % original colour removed.

The liquid flowing from the ppt. obtained in expt. (j.) gave—

Volatile matter	8·4 grs. per gall.
Mineral „	24·5 „
Total	32·9 „

Before clarification the liquid contained—

Volatile matter	81·9 grs. per gall.
Mineral „	119·0 „
Total „	200·9 „

(p)	5 lbs. $CaCl_2$ 1·5 lbs. Fe_2Cl_6 11·0 lbs. SO_3	per 1,000 galls. (neutral iron sol.)	Filters slowly. Filtrate coloured blue.
(q.)	5 lbs. $CaCl_2$ 1·5 lbs. Fe_2Cl_6	per 1,000 galls. (neutral iron sol.)	Similar to (p.)
(r.)	5 lbs. $CaCl_2$ 1·5 lbs. Fe_2Cl_6 with 3·0 lbs. HCl (Acid solution of iron.)	per 1,000 galls.	Filters clear. Filtrate slightly yellow.
(s.)	5 lbs. $CaCl_2$ 1·5 lbs. Fe_2Cl_6 2·0 lbs. HCl	per 1,000 galls. (neutral iron sol.)	Filtrate blue and turbid.
(t.)	5 lbs. $CaCl_2$ 1·5 lbs. Fe_2Cl_6 3·0 lbs. HCl	per 1,000 galls. (neutral iron sol.)	Filtrate coloured; not very clear.
(u.)	5 lbs. $CaCl_2$ 3 lbs. HCl.	per 1,000 galls.	

To the filtrate from the foregoing—

2 lbs. Fe_2Cl_6 (neutral) per 1,000 galls.
? Lime (till faintly alkaline). — The filtrate from the iron was good.

(v.)	5 lbs. $CaCl_2$ 4 lbs. SO_3, sulphuric acid calculated as anhydride.	per 1,000 galls.	Filtrate slightly alkaline.
(w.)	5 lbs. $CaCl_2$ 20 lbs. SO_3	per 1,000 galls.	Filtrate slightly turbid.

Mixture of Polluted Liquids from Woollen Mills.

20 lbs. sulph. acid 4·12 lbs. Fe_2Cl_6 12 lbs. CaO	per 1,000 galls.	Filtrate colourless.
20 lbs. sulph. acid 0·82 lb. Fe_2Cl_6 5·0 lbs. CaO	per 1,000 galls.	Filtrate colourless.
lbs. O. V. 0·41 lb. Fe_2Cl_6 4·0 lbs. CaO	per 1,000 galls.	Filtrate slightly coloured.
5 lbs. $CaCl_2$ $8\frac{1}{4}$ lbs. Fe_2Cl_6 CaO	per 1,000 galls.	Colourless.
2·5 lbs. $CaCl_2$ 2·1 lbs. Fe_2Cl_6 6·6 lbs. HCl ? CaO	per 1,000 galls.	Colourless.

APPENDIX No. 2.

Handed in by Mr. W. NAYLOR, F.C.S., Assoc. M. Inst. C.E.

REPORT on the NATURE and TREATMENT of MANUFACTURERS' WASTE EFFLUENTS.

By W. NAYLOR, F.C.S., Assoc. M. Inst. C.E.

RIBBLE JOINT COMMITTEE.
Walton's Parade, Preston,
March, 1893.

To the Members of the Sub-Committee appointed to consider the Pollution of Rivers by Manufacturers' Waste.

Gentlemen,

As instructed at the meeting of the Ribble Joint Committee in December last, I beg to present herein the main facts to be considered in dealing with the cases of river pollution by industrial waste, which were then referred to you by that Committee.

The branches of industry concerned are:—

1. Bleaching (Cotton).
2. Dyeing and Colour Printing (Cotton).
3. Paper Manufacture.
4. Tanning.
5. The Manufacture of Alkali and various Chemicals.

Before methods of dealing with the different kinds of refuse are considered, it would be perhaps desirable to give an idea as to what each kind of waste practically consists of.

FIRST.—BLEACHING COTTON.

The object of the calico bleacher is to remove as much of the foreign and objectionable matter from the woven fabric as possible. This consists of the natural resinous, fatty, waxy colouring and albuminous matter and the artificial matter introduced in the sizing of the warps, as well as adventitious dust, dirt, and grease.

The nature of weavers' size varies in different mills, some sizes being subject to patent law.* The composition of a common size, without loading, is given by O'Neil as follows:—1cwt. of potato starch, 6lbs. of tallow, 6lbs. of soap, 1lb. of sulphate of copper; the woven fabric to contain five per cent. dry. Appendix 2.

A loading is often added which may bring the percentage of size to even 30, though calico printers as a rule work with pieces containing less than this amount.

Assuming the calico to contain only five per cent., then, when 10,000 pounds weight of cloth is put into the kiers, a bleacher has to deal with 30lbs. of tallow, fatty salt of copper equal to 15lbs. of tallow, and 448lbs. of starch, or nearly 5cwt. as the lowest total.

The process of bleaching, though differing in almost every mill according to the market supplied or as to whether it be for dyeing or printing only, is in Lancashire mills substantially as follows:—

1. The pieces are washed to remove loose dirt and to soften the starch, etc. (steeping).
2. Boiled in milk of lime to decompose waxy, greasy, and resinous matters as well as soluble soaps into insoluble soaps.
3. Washed. Some weavers' starch lost.
4. Passed through a sour of weak acid. Lime soaps converted into fatty acids and salts of calcium. Any lime left in cloth is dissolved, as are also any metals in size.
5. Washed.
6. Boiled in resinate of soda or alkaline substitute. Fatty acids dissolved. Vegetable brown colours loosened.
7. Washed.
8. Passed through chlorine solution or "chemic." Colouring matter bleached.
9. Washed (sometimes omitted).
10. Soured again in weak acid.
11. Washed for final cleansing.

In order to note exactly the extent of pollution caused by each of these steps in the process of bleaching, samples were obtained through the kindness of Mr. Wood, from Brinscall Bleach and Print Works in January, 1893, which gave results as follow:—

* Patent No. 62, January, 1874:—40lbs. of sago, 10lbs. of flour, 10 gallons of water, 1lb. of paraffin or white wax, 2lbs. of tallow, 2lbs. of soap, 2oz. French chalk, 1 gill or more of mixed boiled linseed or castor oils; there may also be added gum guiacum, neatsfoot, or cocoa oil, and spermaceti.

Series A.—BLEACHING PROCESS AT WOOD'S, BRINSCALL.

Number of Sample.	Date.	Nature of Sample.	PARTS PER 100,000. Dissolved Solids. Mineral.	Dissolved Solids. Organic.	Total Dissolved Solids.	Suspended Solids. Mineral.	Suspended Solids. Organic.	Total Suspended Solids.	Total Solids.	PARTS PER 100. Acidity. Normal NaHO requir'd.	Alkalinity. Normal H_2SO_4 requir'd.	Relative Volumes
												Gallons.
103	23rd, 24th, 25th, 26th, and 27th of Jan., 1893.	Water Supply from Reservoir.	8·0	10·3	18·3	Nil.	Nil.	Nil.	18·3	Neutral.		—
104		First Wash (or Steep), I.	42·9	145·1	188·0	16·4	55·9	72·3	260·3	·2	—	20,000
105		Spent Lime from Keir, II.	134·3	613·8	748·1	9·0	105·0	114·0	862·1	—	1·4	1,600
106		Wash out of Lime Keir, III.	22·8	25·7	48·5	6·8	9·7	16·5	65·0	—	·3	20,000
107		First (or Grey) Sour, IV.	288·9	131·4	420·3	8·8	55·9	64·7	485·0	32·7	—	1,600
108		Wash out of Grey Sour, V.	42·7	22·0	64·7	3·4	10·7	14·1	78·8	1·5	—	20,000
109		Spent Ash Liquor (Soda), VI.	802·1	556·4	1358·5	Taken with dissolved Solids.			1358·5	—	10·1	1,400
110		Wash out of Ash Keir, VII.	30·7	20·2	50·9	3·0	9·0	12·0	62·9	—	2·0	20,000
111		Spent "Chemic," VIII.	114·3	29·8	144·1	8·6	11·5	20·1	164·2	—	·3	1,600
112		Second (or White) Sour, X.	126·5	47·5	174·0	1·2	7·1	8·3	182·3	10·9	—	1,600
113		Wash out of White Sour, XI.	8·2	12·1	20·3	2·9	11·2	14·1	34·4	·3	—	20,000

Appendix 2.

In this series of analyses it will be noticed that the bulk of the solids lie in—

Series A[1].	Organic Solids.	Inorganic Solids.	Total Solids.	Relative Volume.	Product of Relative Volume and Total Solids.
				Gals.	
The First Steep.	201·0	59·3	260·3	20,000	5,206,000
Spent Lime from Keir.	718·8	143·3	862·1	1,600	1,379,360
Grey Sour -	187·3	297·7	485·0	1,600	776,000
Spent Ash -	556·4	802·1	1,358·5	1,400	1,901,900

The sum of the relative volumes of these liquors compared with the whole volume of waste is as 1 to 4.

If the relative volume of the water used in any particular step of the process be multiplied by the total solids, the product will, of course, be the relative amount of solids carried out into the river by the water used in this step of the process. (To convert parts per 100,000 to grains per gallon multiply by ·7.)

Estimated in this manner, the total solids contained in these four (Series A1) together, are to the total solids in the whole of the water turned out, as 9 to14.

Since then these liquors forementioned (A1) constitute only one-fourth of the whole, but contain nine-fourteenths of the solids, the question arises as to whether it should not be made compulsory to treat these liquors at least, and the option given as to whether the others be treated or not.

It follows, too, that the remaining liquors amount to three-fourths of the whole, but only contain five-fourteenths of the total solids.

The recommendation to pass away as harmless the waste waters was made by Sir Henry Roscoe in the preliminary report submitted to "The Mersey and Irwell Joint Committee" in March last, and previously to this by the Rivers Pollution Commissioners.

It should also be pointed out that the ratio of organic to inorganic matter in the forementioned A1, is as 16·5 to 13, and in the remaining six as 21 to 37, which indicates greater liability to decompose in the series A1.

The remaining six alluded to are—

—	Organic Solids.	In-organic Solids.	Total Solids.	Relative Volume.	Product of Relative Volume and Total Solids.
				Galls.	
Wash out of Lime Keir -	35·4	29·6	65	20,000	1,300,000
Wash out of Grey Sour -	32·7	46·1	78·8	20,000	1,576,000
Wash out of Ash Keir -	29·2	33·7	62·9	20,000	1,258,000
Spent "Chemic" - -	41·3	122·9	164·2	1,600	262,720
White Sour - - - -	54·6	127·7	182·3	1,600	291,680
Wash out of White Sour	23·3	11·1	34·4	20,000	688,000

After those liquors referred to as being the worst, come the "Spent Chemic" and "White Sour" in order of contaminating tendency; and as the relative volume of these two is but 3,700, they would be advantageously classed with the first four as requiring treatment.

But it should be borne in mind that in many instances bleach, dye, and paper works, are laid out in such a manner as to preclude the separation of the liquors in this way without entailing considerable expense. The keirs, becks, washing machines, etc., are placed sufficiently low to allow of being fed from the water supply by gravitation, and the outlets placed just sufficiently high to reach the water line of the river a little above its normal flow.

Delivery pipes from the various machines are run here and there in every direction, dodging first one obstacle and then another according to circumstances, but eventually reaching the river.

In each of such cases, a systematic mode of concentration or rejection of liquors for treatment would necessitate the movement of machines, upraising of floors, or multiplicity of pipes to an extent beyond all reason, and no course is left but to subject the whole of the effluent (mixed) to treatment.

In addition too, to the *quantity* of solids borne by a bleacher's waste, the amount of organic matter therein also demands notice. Bleachers, I fancy, get credit generally for much purer effluents than they really turn out.

The process of bleaching is essentially a process of washing, and the objectionable matter washed out is more liable to decomposition than appears at first sight.

Professor Hummel (Dyeing and Calico Printing) speaks on this subject as follows :—

"In bleach works the refuse liquids consist of alkaline and soapy solutions, together with such as contain calcium chloride, traces of bleaching powder, and free acids. Here are all the elements necessary to mutual purification, if allowed to mix together in due proportions; the calcium will precipitate the soap solutions, while the free acids will neutralise and precipitate the alkaline liquids and decompose the waste solutions of bleaching powder."

With very great care this statement may no doubt be verified on the part of the bleachers, but, unfortunately, conveniences for the detention of one liquor until a favourable opportunity for its action upon another are not always to hand, and there is certainly no case in the Ribble Watershed where such a course is followed. The idea, nevertheless, has been laid hold of and contorted into every imaginable form, until now one is often informed with childlike assurance that bleach waste has only to be admitted to the river, when it will purify itself and the river afterwards for miles.

The reservoir or lodge immediately above the Pincroft Dye Company, Adlington, which is fed principally by water containing bleach waste from works higher up the stream, in summer becomes neither more nor less than a huge, stinking cesspool, bubbling continually with gases which arise from decomposing sludge.*

The following analyses of bleach liquor indicate its putrescent nature, though it will be noticed the organic nitrogen is small in quantity.

* The lodge was let down on 9th March, 1893, owing to an accident to the dam, when I saw on the bottom 15,000 tons of sludge. Some years ago an attempt was made to empty it, but after a few days the idea was abandoned.

Series B.—Analyses of Average Bleach Waste showing Organic Matter. Appendix 2

Number of Sample.	Date.	Nature of Sample.	Parts per 100,000. Total Solids.	Free Ammonia.	Nitrogen as Nitrites and Nitrates.	Chlorine.*	Organic Carbon.	Organic Nitrogen.	N / C	Inorganic Nitrogen.	Total Nitrogen.
129	9 Feb. 1893 -	Samples of waste bleach liquor taken every three hours and mixed. (Whalley Abbey Print Co.)	186·0	·012	0	10	1·45	·056	26 to 1	·009	·065
117	3 Feb. 1893 -	Samples (coloured†) of waste bleach liquor taken half hourly and mixed. (Grafton and Co., Accrington).	86·1	·03	·1	40	9·03	·87	10 to 1	·125	·995
128	10 Feb. 1893 -	Samples of waste bleach liquor taken half hourly and mixed. (Stanning's, Leyland).	136·5	·24	0	130	26·124	2·734	9 to 1	·19	2·924

* Due principally to acids. † Coloured by "back pieces."

Note.—The above samples and all to follow were accepted from manufacturers as *bona fide* specimens of waste, but can only be strictly considered as such for the time defined.

Second.—Dyeing and Calico Printing.

Dyeing.

Dyeing is briefly the process of passing fabrics through solutions of colouring matter, under conditions favourable either to the temporary or permanent retention of the colouring matter by the fabric. There are many colours which, though not readily absorbed by the fabric itself, are capable of fixing themselves upon some agent with which the fabric may be saturated, which agent is termed a mordant. Different mordants are used for different colours, one colouring agent often changing its tone altogether with a different mordant.

The colours used in the Ribble Watershed are principally alizarine, logwood, and indigo, from which there is no waste thrown into the river until after the point of making coloured solutions or dyes.

Goods are passed through the solutions after mordanting, then washed; certain colours are afterwards soaped also, that they may acquire a finished, polished, or brighter appearance, and then washed again.

Calico Printing.

Calico printing is the art of dyeing designs topically upon calico having either a white or already coloured ground. The colour is first placed upon wooden blocks or engraved copper cylinders, from which it is afterwards transferred to the fabric. This causes calico printers' waste liquor to be of a more obnoxious character than that from dyers, for before the colour will adhere to the blocks or engraved cylinders it must be thickened by a paste, which paste is afterwards washed out, the colour being left behind. The principal thickening agents are:—Albumen, casein, china clay, pipe clay, dextrin, glue, gluten, glycerine, gum senegal, gum tregacanth, molasses, lead sulphate, potato starch, salep, shellac in borax, sugar, wheat flour, wheat starch, zinc chloride, and zinc nitrate. (Gardner).

The "whites" or pieces to be printed are run between the plain and engraved cylinders, together with blankets and "back pieces" or "back greys," which in due course become themselves smeared or coloured, and upon being washed and bleached give a colouration to the bleach waste.

Series C.—Analyses of Dye and Calico Print Liquors.

Number of Sample.	Date.	Nature of Sample.	Parts per 100,000. Dissolved Solids. Mineral.	Dissolved Solids. Organic.	Total Dissolved Solids.	Suspended Solids. Mineral.	Suspended Solids. Organic.	Total Suspended Solids.	Total Solids.
103	26 Jan. 1893.	Water from Wood's Reservoir, Brinscall.	8·0	10·3	18·3	—	—	—	18·3
115	26 Jan. 1893.	Waste Dye (Wood's) from becks.	68·0	256·2	324·2	1·0	41·5	42·5	366·7
116	26 Jan. 1893.	Wash from Dye Becks (Wood's).	22·1	48·2	70·3	42·0	118·9	160·9	231·2
118	3 Feb. 1893 -	Dye and Calico Print Waste, Grafton & Co., Accrington.	146·1	41·9	188·0	10·2	6·1	16·3	204·3
135	9 Feb. 1893 -	Dye and Calico Print Waste, Whalley Abbey Print Co.	26·4	28·3	54·7	8·0	1·4	9·4	64·1
130	10 Feb. 1893-	Dye Waste, Stanning's, Leyland.	90·4	80·2	176·6	12·2	31·2	43·4	220·0

Appendix 2.

Series D.—Analyses of Average Dye and Calico Print Waste.

SHOWING ORGANIC MATTER.

Number of Sample.	Date.	Nature of Sample.	Total Solids.	Free Ammonia.	Nitrogen as Nitrates and Nitrites.	* Chlorine.	Organic Carbon.	Organic Nitrogen.	C/N	Inorganic Nitrogen.	Total Nitrogen.
118	3 Feb. 1893 -	Sample of Waste Dye (analine) and thickening, Grafton & Co., Accrington.	204·3	·27	0	30	6·58	·329	20 to 1	·22	·549
130	10 Feb. 1893 -	Samples of Dye Waste (analine), Stanning's, Leyland.	220·0	·36	1·2	37	33·71	3·09	11 to 1	1·49	4·58

* Due principally to acids.

It will be seen from these analyses that the character of dyers' refuse is almost as objectionable as it appears. The colour itself, however, is very difficult to obliterate entirely, though this can be done with proper appliances as will be seen later. A small quantity of colour will give a very decided tint to a large volume of water,* the amount left in the dye becks to be thrown away being only that which remains unabsorbed after it has been worked until its value is less than the cost of running the machinery. The chances of its being removed in the becks at any time are small, for since these are heated by steam in contact with the liquor, which steam is continually condensing, the volume of dye liquor is continually increased, and the strength decreased accordingly, and the weaker the strength of the liquor the longer the time required for a given piece of fabric to abstract the colour. An excess of colour is always added too, otherwise processes which now require hours would require months. The thought of abstracting all dye in the dye-house must therefore be dismissed until mordants are discovered which will take up all the colour from solution, and that quickly.

The Treatment of Bleach and Dye Waste.

A.—Bleach Waste.

The efforts recently put forth by local governing authorities to prevent that pollution of streams which has been steadily increasing for years with the increase of population and development of industry, has caused to be put upon the market appliances and agents, whose name is legion, for the purification of waste liquors. Summed up they are methods of—

1.—Filtration.
2.—Precipitation.

Prior to the consideration of these methods of treatment, let it again be noted that the liquor now in question is one having abundance of solids both in solution and suspension, a considerable proportion of each being of a somewhat decomposable nature.

The purification of this liquor therefore means the reduction to a rational extent of—

1.—The suspended solids.
2.—The dissolved solids.

Now filtration, with any sense of modesty, claims nothing more than the mechanical separation of suspended solids by means of a permeable diaphragm. True, some of the very extensive sand filters for potable waters may abstract a proportion of dissolved matter, but no practicable filter for manufacturers' waste can do this, and the filtrate, though presenting often a satisfactory appearance, contains much that is to be objected to in solution, *this dissolved matter being liable to precipitate itself later on in the river bed.*

Herein lies the great objection to mechanical filters; the clear filtrate, *almost saturated with dissolved matter*, will often deposit a large amount even upon being left alone in a bottle, while the probability of such a deposition in a stream when in contact with liquors of dissimilar nature is even greater.

These remarks, it will be noted, do not refer to sewage filtration where bacteriological influences are at work. A manufacturer's filter to be of use must be quick—aided by steam, pneumatic or hydraulic pressure—and frequently washed out, thus destroying the effects of any microbes, if present, and their presence is doubtful.

Turning now to precipitation the questions present themselves:—

1.—Will precipitation remove all or any suspended matter?
2.—Will it increase or decrease the dissolved matter?
3.—How is the organic dissolved matter affected?

It will be necessary first to choose a precipitant from the host for which many virtues are claimed. In this choice I have been guided by the report of Dr. Angus Smith, F.R.S., 1882, to the Local Government Board, on the Rivers Pollution Prevention Act, 1876—a copy of which is forwarded with this report.

On page 82 *et seq.*, it will be seen that Dr. Smith relied upon the heavy precipitate formed when a solution of an iron salt is brought in contact with milk of lime. In dealing with sewage precipitants something more might be said concerning the claims of other agents, but for trade waste, though very many precipitants have appeared since 1882, iron salts appear to be the keynote of all. They may be adulterated, renamed, or patented, *but iron salts are nearly always there.*

For bleach waste I have tried, in many proportions, for this report, ferrous sulphate and milk of lime with satisfactory results. From the experiments made, I will only abstract that with bleach waste from the Whalley Abbey Print Works, which was the waste containing about the greatest quantity of total solids before treatment.

* ·05 grammes of indigo will colour 20,000,000 times the quantity of water, on a white ground, at a depth of 1 metre (39 inches).—Dr. Fleck.

Series E.—Analyses showing Result of Treatment by Lime and Iron Salts.

Number of Sample.	Date.	Nature of Sample.	Dissolved Solids. Mineral.	Dissolved Solids. Organic.	Total Dissolved Solids.	Suspended Solids. Mineral.	Suspended Solids. Organic.	Total Suspended Solids.	Total Solids.	Organic Carbon.	Organic Nitrogen.	Free NH_3.	Remarks.
129	9 Feb. 1893 -	Whalley Abbey bleach waste collected at three hourly intervals.	136·3	39·8	176·1	5·2	4·7	9·9	186·0	1·45	·056	·012	Acid reaction.
119	—	Same after treatment with two grains per gallon Ferrous sulphate ($FeSO_4 . 7H_2O$) and seven grains lime (CaO).	98·8	19·3	118·1	–	–	–	118·1	1·126	·045	0·75	Neutral reaction.
Reduction per cent.			28	51	33	100	100	100	36*	22	19		

* Most bleach works effluents contain more suspended matter than this.

Appendix 2.

It is here shown that all suspended matters are removed; the total dissolved solids reduced by 33 per cent., while the organic matter is reduced by 51 per cent.

In all the other cases, whether total dissolved solids were much higher or much lower, there was a marked reduction in both inorganic and organic matter.

In reply, then, to the questions asked *supra*, these figures and facts point unmistakably to precipitation being cheaper and more efficient than filtration, and I hope to be able to give details of a trial on a large scale, when the tanks now in progress at Messrs. Stanning's, Leyland, are completed.

B.—Dye and Calico Print Waste.

The foregoing analyses have shown calico, print, and dye wastes to be of a very objectionable character, too, and that they certainly demand treatment. Dr. Angus Smith showed that as a precipitant ferric chloride had a better effect on the colouration than ferrous sulphate (page 83, Report to the Local Government Board, 1882), and he also supplemented precipitation by aeration—with good results.

Dated August 12th, 1889, Mr. Hunt, F.I.C., Leeds, presented a Report to the Leeds Leather Trade Association, on "The treatment of the effluent from the Buslingthorpe Tannery, with special reference to a week's work at the Tanks," from which I am kindly permitted by the author to extract the following:—

"In your report of 8th May, 1888, a description of the tank is given. Since then an improved method of agitating the contents of the tank during precipitation, has been adopted. Perforated pipes have been fixed near the floor of the tanks. Through these pipes a strong current of air is forced by one of Meldrum's steam injectors. The air passing up through the water agitated it perfectly, and the process of precipitation is improved and shortened. The smell during precipitation complained of before is not now noticeable. Sulphate of iron (copperas) has been used for precipitating, a mixture of equal weights of copperas and alumino ferric cake giving good results."

More recently, 1892, Messrs. Mather and Platt, Salford, have brought out a similar arrangement for precipitating and aerating dye liquors, which I understand, has fulfilled all it was expected to do, with alumino ferric and lime as precipitating agents. The system of aeration has also been practised successfully by Messrs. R. A. Sanderson and Co., Galashiels.

In your laboratory at Preston experiments have been made on a small scale—and in the solution of this particular problem, namely, removal of colouration, a small experiment is quite as conclusive as a large one—with ferric chloride and lime, the results being eminently satisfactory. The colouration was *completely* removed after fifteen minutes aeration, the effluent resembling distilled water in transparency.*

The improvement in other respects can be noted from an analysis given below of the Whalley Abbey dye and print waste, before and after treatment. This sample is chosen as the one being most deeply coloured—reddish purple—and though it contains but a small quantity of organic matter and solids, if small quantities are affected the larger quantities are pretty safe.

* The addition of a little sulphurous acid has a good bleaching effect often—the acidity being afterwards neutralised by lime.

E. 2.—Analyses showing Result of Treatment by Lime, Iron Salts, and Aeration.

Number Sample.	Date.	Nature of Sample.	Dissolved Solids. Mineral.	Dissolved Solids. Organic.	Total Dissolved Solids.	Suspended Solids. Mineral.	Suspended Solids. Organic.	Total Suspended Solids.	Total Solids.	Organic Carbon.	Organic Nitrogen.	Free Ammonia.	Remarks.
135	9 Feb. 1893.	Print and Dye Waste, Whalley Abbey.	26·4	28·3	54·7	8·0	1·4	9·4	64·1	4·79	·425	·03	Slightly acid reaction.
120	—	Same after treatment with lime (CaO), ferric chloride (Fe_2Cl_6), and aeration.	28·2*	21·1	49·3	0	0	0	49·3	1·094	·042	·06	Neutral reaction.
Reduction per cent.			—	26	10	100	100	100	23	77	90	—	—

* More than *quantum suff.* of precipitant added.

I therefore beg to submit for your earnest consideration the advisability of recommending this course for manufacturers in the watershed, for the cost of running a small air compressor or Sturtevant blower is but small, and the removal of coloration from our rivers, would, in the eyes of the general public, cover a multitude of other sins, and at the same time certainly be an important step towards a more complete purification to follow.

The Disposal of Precipitated Sludge.

The volume of sludge arising from the use of iron salts and lime is greater than that from the use of many other precipitants. At Messrs. Stanning's, 60 gallons of liquor yielded with these agents 33lbs. of wet sludge—that is, about half-a-pound to a gallon, or about a ¼oz. of dry solids if the water be deducted, which amounts to 95 per cent. By the cautiously sparing use of precipitants these figures may be somewhat reduced, but not a great deal. Roughly speaking it will mean 4cwt. to 1,000 gallons treated, which is equivalent to some tons of sludge per diem in all cases.*

Manufacturers who have made a life-long study of the subjects upon which I have presumed to make as cursory remarks as possible, are fully cognisant of this fact, which, more than any other, I am inclined to believe is the stumbling block to the general adoption of precipitation. From correspondence with manufacturers up to the present it is to be gathered that the majority of them stand back on these grounds, while others have circumstantial reasons, and just a few still plead ignorance, thinking perhaps, that "where ignorance is bliss, 'tis folly to be wise."

Attempts have been made to utilise sludge for the manufacture of—

1.—Cement;

2.—Manure;

3.—Illuminating gas; and

4.—For fettling puddling furnaces.

In no cases as yet have the results been financially satisfactory, and in the fourth instance not satisfactory at all, the percentage of iron oxide in the sludge being too small.

Analyses of sludge from bleach liquor only, calico print waste only, and from the tanks of Woods', at

* Messrs. Stanning calculated independently that they abstract 5 tons per diem of dry solids from fabrics. This, amounting to 100 tons wet sludge, about coincides with the figures given above. Effluent 500.000 gallons.

Appendix 2

Brinscall, where logwood chips form a large proportion of the waste, have been made with results as follow:—

Series F.—Analyses of Precipitation Sludges well dried at 212° F.

——	134. Sludge from Woods', Brinscall (principally Logwood Chips) after Lime and Ferric Chloride.	133. Bleach Waste (Stanning's) Sludge after Lime and Iron Sulphate.	132. Dye and Print Water Sludge (Laboratory) after Lime and Ferric Chloride and aeration.
Moisture	1·09	2·31	2·52 per cent.
Organic Matter, CO_2 &c.	96·73	36·83	28·66 per cent.
Inorganic Matter	2·19	60·86	68·81 per cent.
Nitrogen, equal to Ammonia.	—	·004	Trace only.
Phosphoric Acid	—	·003	·001
Inorganic Matter. Iron Oxide (F_2O_3).	—	—	13·94
Inorganic Matter. Lime (CaO)	—	—	39·27
Inorganic Matter. Silica Alumina, &c.	—	—	6·43
Gases given off per ton of Sludge.	7,762 cubic feet.	1,794 cubic feet.	287 cubic feet.

Cement.

The manufacture of cement to stand the breaking tests of present day engineers is a difficult matter with the best materials in good condition, while with such sludges as those above quoted, where all the constituents of a good cement are not present, and where other substances, difficult to abstract, and which would have a deleterious effect upon the proper and useful constituents of cement are present, the difficulty is increased.

And in addition to the disadvantages of its wet condition and the additions or abstractions necessary, even if possible, such sludges could hardly compete with the raw material for cement making at present prices; for the prime cost of cement raw materials—lime-stone and clay—form only a small item in the cost of production, the rest being swallowed in burning.

Experiments are still being made with a much more likely material, namely, the sludge from Chance's Sulphur Recovery Process, which is considerably over 90 per cent. carbonate of lime, and until these have been brought to a successful issue there is not much hope for either sewage or manufacturers' sludge.

Manure.

The value and price of a manure are based upon the quantity of nitrogenous matter and useful phosphoric acid therein. In sewage sludges these fertilising agents sometimes amount to a quantity worthy of consideration; but in analyses given here they are the merest traces, and considering the source of the sludge no more could be expected.

Gas Making.

The poorest coal for profitable gas making must give off about 8,000 cubic feet to the ton, the best give about 15 to 18,000. None of the three sludges above approaches this figure, and in their raw state they cannot therefore be utilised for this purpose. That from Woods' at Brinscall comes nearer than the others, owing to the large amount of vegetable matter present. Practically the sample was logwood chips dried, but the amount of gas produced probably would not justify the laying down of gas and drying plant. The gas from this far exceeded in calorific value the gases from the other two samples of sludge, volume for volume. Just now it is being sold to a Manchester firm, which carbonises the woody matter, so obtaining pyroligneous acid, naphtha, pitch, and charcoal; but its value for this purpose is not more than nor even as much as that of wet sawdust, which could be similarly utilised, and, as a matter of fact, the price obtained barely covers carriage.

The case of Messrs. E. Schwambourne at Aachan is mentioned by Hummel, which deserves notice.

Here the refuse wash from raw wool, and the milling and washing of cloth, is precipitated by lime. The composition of air-dry precipitate is as follows:—

Water	3·11 per cent.
Lime and Ferric Oxide	18·47 „
Fatty matter	71·96 „
Waste Fibre, &c.	6·46 „

Mixed with coal, this precipitate serves for the manufacture of illuminating gas.

The mixture of lime soaps* from dye and print works with the sludge might be similarly tried, though it is questionable whether the fat and other combustible matter would reach 78 per cent. as in the case above, and much would depend also upon the price received for fat recovered, compared with the value of the gas made, after deducting working expenses and interest on plant capital.

The subject of sludge disposal, then, must here be left unsettled. It is a point for each manufacturer to settle for himself; but as there is nothing in it of much value, it is very questionable whether anything will ever be got out of it, and one is tempted to say "Ex nihilo nihil fit."

Comparisons cannot well be made with this and the recovery of sulphur, soda, or acid. Before such processes of recovery were invented, in the first of these cases all the sulphur used by acid or alkali makers was simply being thrown away with the waste (except that little left in pyrites clinker), and makers were of course forced to buy more at high prices to keep going. In the second case also, paper makers were throwing away soda and buying fresh. In the third, acid makers were sending up the towers or flues a proportion of the very acid they were making to put on the market.†

But there is no analogy between these and the case of precipitated sludge, which is exactly the dirt and refuse that has been in the way from the very beginning.

That a storage place, or a use for it cannot be found is no excuse for non-treament; for the object of the Joint Committee, as I understand, is only to see that such refuse is not brought from the four corners of the earth and thrown to stagnate along the bed of the river Ribble.

Grease Recovery.

It has been previously mentioned that certain colours are brightened by passing them through a solution of soap. This soap solution, after using, is in some cases thrown away, and in others attempts are made to recover the grease therefrom.

Soap is formed by the combination of a fatty acid with a base. The base may be an alkali, alkaline earth, or a mineral.

The fatty acids of a soap so formed may again be separated and recovered by—

First.—Treating the soap with an acid which has a greater affinity for the base than the fatty acid has, when of course these latter acids are liberated.

This is done in many cases. The soap liquors are run into tanks, mixed with hydrochloric or sulphuric acid, when the acid added forms a chloride or sulphate respectively with the base of the soap, and the fatty acids are liberated, rising to the surface, and may be skimmed off, or filtered.

This method is practised at the Whalley Abbey Print Company and Steiner's, Church, with the following result:—

* The lime from lime soaps would by this means be kept free of the rivers.

† Apart from this I am informed by a large firm of indigo users in the Ribble Basin that since increasing the size of the precipitation tanks, at the suggestion of the Joint Committee six months ago, they have saved an extra amount of indigo, value £400.

Appendix 2.

SERIES G. 1.—ANALYSES OF SOAP LIQUOR BEFORE AND AFTER TREATMENT BY ACID.

No.	Date.	Nature of Sample.	Parts per 100,000.				Parts per 100.	
			Suspended and Dissolved Solids.		Total Solids.	Grease (Fatty Anhydrides).	Acidity. Normal Caustic Soda required.	Alkalinity. Normal Sulphuric Acid required.
			Mineral.	Organic.				
156	8/2/93	Soap Liquor (Whalley Abbey P. Co.) before treatment.	264·1	578·8	842·9	386·8	—	·2
157	8/2/93	Same after treatment with Acid (HCl.)	62·8	811·3	874·1	4·0	10·5	—
152	16/2/93	Soap Liquor (Steiner's) before treatment.	94·0	166·3	260·3	152·4	—	·3
153	16/2/93	Same after treatment with Acid (HCl.)	160·5	388·2	548·7	220·0	·3	—
158	1/3/93	Thom's before treatment - -	68·7	231·6	300·3	76·4	Sample erroneously taken after being acidified.	
159	1/3/93	Same after treatment - -	60·2	124·5	184·7	28·8	·6	—

Second.—The fat may be recovered also by treating the soap with a second base, which has a greater affinity for the fatty acids than the base already combined with them, when a second soap will be formed, and, if insoluble in water, will form a precipitate that can be collected.*

The Rivers Pollution Commissioners reported as follows on treatment by the second method:—

"But the action of acid is not the only method by which this decomposition of the soap and the separation of the grease could be effected; for the soda of the soap it is possible to substitute other bases, such as lime or oxide of iron, and the lime or iron soap so produced is insoluble. We believe that lime has been proposed, if not used, as a means of treating the soap suds, but we have not heard that salts of iron have been thought of. If lime were employed it would be in a state of burnt lime made into a thin paste with water, known as 'milk of lime.' We have made repeated trials of lime in the laboratory, and can speak very favourably of the action. When added judiciously, and without excess, it causes a ready separation of the soap suds into clot and clear liquid, and the action is greatly aided by the addition of a small quantity of alum. . . . The magma separated from the soap suds by lime would not be greasy; it would be, as we before said, an insoluble soap. The liquid flowing away would be *alkaline* from free *soda*, not acid as it is by the present method; indeed, the rivers would be doubly benefited by the discharge of clear instead of foul liquid, a soft water instead of water laden with salts. The insoluble compound would require to be decomposed by acid subsequently, but this would be done by the extractor at his works, and under favourable circumstances, and *the sulphate of lime produced would not need to pass to the rivers.*

"The use of salts of iron for cleansing the soap suds might prove equally beneficial. Perchloride of iron in solution, added to the soap waters, produces a ready separation of the fatty matters, and a clean liquor for discharge. Sulphate of iron, or green copperas, which is largely used in the dying of black goods, is also available for this purpose. The iron soap produced would be subsequently decomposed by sulphuric acid, and the iron recovered as sulphate of iron for further use."

Lime is used in some cases in this watershed, in the manner just described, but the lime soaps formed are not sent away to the "extractor at his works," but are treated by acid on the spot, and the weak acid left, together with salts formed from this treatment, then mixed with the suds before liming, the consequence being that just the same amount of salt goes into the river as would be in case lime were not used at all, but acid only. Here, therefore, the statement in the extract printed in italics* is valueless, and, as a matter of fact, there is more chloride of lime† present in the effluent from Drew's, where lime is used and the grease afterwards recovered from the lime soap, than in the effluent from Thom's, where acid only is used.

* Soaps formed from fatty acids and soda or potash are soluble in water. Those formed from fatty acids and alkaline earths, or from acids and minerals, are insoluble in water.

* Not italicised in Report of Commissioners.

† Hydrochloric acid is used at Drew's, not sulphuric.

SERIES G 2.—FAT EXTRACTION BY LIME. ANALYSES OF SOAP LIQUORS BEFORE AND AFTER TREATMENT.

No.	Date.	Nature of Sample.	Parts per 100,000.				Parts per 100.	
			Suspended and Dissolved Solids.		Total Solids.	Grease (Fatty Anhydrides).	Acidity, Normal Caustic Soda required.	Alkalinity, Normal Sulphuric Acid required.
			Mineral.	Organic.				
148	6/2/93	Drew's Waste Soap Liquor before treatment.	32·0	552·3	584·3	312·0	—	·4
149	6/2/93	Same after treatment by lime, together with liquor from final fat extraction.	240·5	62·2	302·7	—	—	·2
150	16-17-18/2/93	Grafton's, before treatment.	56·1	113·9	170·0	16·81	—	·4
151	16-17-18/2/93	Same after treatment -	70·2	66·2	136·4	Trace.	—	·3

Appendix 2.

Messrs. Thom formerly used lime and alum, but have discontinued the practice in favour of acid only. The fats after being separated from the soaps by acid sooner or later, are caught by sawdust filters. The sawdust is then hot pressed and the exuded fat distilled to obtain olein, stearin, etc., for market.

The fats in the effluents above are due to ineffective filtering and bad management generally.

Series of Analyses G 2 shows the mineral matter in the effluent to go up, as would be expected from the addition of lime, and the organic matter to go down owing to loss of fat.

In the Series G 1 one would expect organic matter to go down and mineral matter to be only slightly affected, as the soda is simply changed from the base of one salt to the base of another. This expectation is realised with Thom's but not with the other two. At the Whalley Abbey Co.'s all solids are higher, but the fats reduced, while Steiner's tanks seem to offer a fair field for a soap or candle factory.

These discrepancies are explained by the following letters received:—

Whalley Abbey Printing Co., Limited,
Whalley, near Blackburn, March 10th, 1893.

Dear Sir,

The reason of the discrepancy between the amount of solid matter in the untreated soap liquor and that in the treated will be that they are two different liquors. When your man came I gave him some of the liquor that was being pumped up then, and also some of the treated liquor that had been standing several hours. Now this soap liquor may vary considerably in strength at different times, according to the class of goods that are being soaped, and for other reasons, and so the liquor may have been quite different to the one coming up at the time I took the samples. If you like I will take samples of the liquor coming up and also of the same after treatment and send them on to you. I should think, however, that this is scarcely necessary, as your analysis shows that we take the fat out of the water.

Yours faithfully,
ALFRED M. HANSON.

Church, Lancashire, 15th March, 1892.

Dear Sir,

Referring to your letter of the 8th instant and your representative's call on Monday last regarding same, we have made a careful examination of our filters, and find that they have become choked up with fat, etc., and this will account for the sample marked "after treatment" being so unsatisfactory as you report. We had not time to test the sample ourselves, otherwise we should have discovered the defect and explained sooner.

We are, however, having the filters reconstructed, and will communicate with you again on completion thereof.

As to your remark that your assistant was not allowed to see the samples taken, we would state that he merely asked for samples, and did not in any way indicate that he wished to see them drawn. If he had done so, we should only have been too pleased to let him see the samples taken.

Yours faithfully,
p. pro F. STEINER AND CO.,
GEO. E. UNTTEY.

IRON SALTS FOR THE RECOVERY OF GREASE.

There is no case in the Watershed where the suggestions of the Commissioners have been followed with respect to the employment of iron salts. This is probably due to the cost as compared with lime or acid.

From experiments with small quantities of soap liquor from Drew's, it is questionable whether the results as given below justify the increased expenditure, especially as upon this recommendation it is not "soft water instead of water laden with salts," but water laden with salts just as though acid only had been used that enters the river. An experiment on a large scale would be interesting.

Series G 3.—FAT EXTRACTION BY IRON SALTS.

No.	Date.	Nature of Sample.	Parts per 100,000.				Parts per 100.	
			Suspended and Dissolved Solids.		Total Solids.	Grease (Fatty Anhydrides).	Acidity, Normal Caustic Soda required.	Alkalinity, Normal Sulpuric Acid required.
			Mineral.	Organic.				
148	6/2/93	Drew's before treatment -	32·0	552·3	584·3	312·0	–	·4
154	6/2/93	Same after treatment by ferrous sulphate.	*281·0	69 7	350·7	Nil	- - Neutral.	
155	6/2/93	Drew's after treatment by ferric chloride.	*185·9	62·4	248·3	Nil	- - Neutral.	

* More than *quantum suff.* of precipitant added.

In the analyses of all effluents from grease recovery processes, it will be noticed that though much of the grease is recovered there remains a large quantity of other solids, more than in some of the works general effluents, and yet in only one instance (Whalley Abbey Print Co.) is any attempt made to treat these effluents further. Their nature should make further treatment by precipitation and aeration imperative, as in all cases they are discoloured also.

The method of grease recovery to benefit the river most appears to be:—

1. Treatment by lime.
2. Exportation of lime soap.
3. Precipitation and aeration of extraction tanks effluent.

Aeration pipes in the extraction tanks would almost pay for themselves in increased efficiency of mixing by means of air.

THIRD.—PAPER MANUFACTURE.

The basis of all papers is vegetable fibre or cellulose, and the object of the paper-maker to divest vegetable growth, esparto grass, linen cuttings, cotton rags, ryegrass, hemp bagging, straw, tarpaulin, ropes, peat, etc., from any other matters associated with this fibre or cellulose. Such associated matters are resins, gums, silicious coatings, fats, oils, and very largely adventitious dirt.

The process is briefly:—

1. Dusting and picking—refuse solid.
2. Boiling raw stuff with caustic soda, to saponify fats, vegetable oils, and resins—soda recovered.
3. Washing raw stuff after boiling with caustic soda, now termed half-stuff—soda recovered.
4. Breaking up half-stuff to pulp and washing in breaking engine—effluent wash water goes to river.
5. Bleaching the washed and broken half-stuff in poacher (or by means of chlorine gas)—bleach liquor used over again if chlorine is not all liberated, otherwise goes to river.
6. Beating bleached stuff to a pulp by means of beating engines, and washing further—effluent goes to river.

7. Passing pulp (after sizing, colouring, and loading) through paper making machine in which it is strained, layered, rolled, and cut, emerging as paper—water from paper machine used over again continually.

In examining the effluents from these processes the spent soda (2 and 3) may be left for the present as it may and ought to be recovered, except perhaps in the cases of mills making brown or shop papers exclusively, where only a small quantity is used. Effluents from 5 and 7, it will be seen, are used over and over again, thus leaving only the wash waters from breaking engines (4) and beating engines (6) to be dealt with, as that from 1 is solid.

Appendix 2.

The effluents (4 and 6) are always more or less foul, depending upon the material in hand and, of course, the particular point of time in the washing process, the machines running generally about one or two hours.

Samples of machine effluents were taken on Friday, 9th March, from Messrs. Dimmock's, Darwen, their natures being depicted below:—

Series H.—Analyses showing Solids in Paper Mill Wash.—Parts per 100,000.

No.	Date.	Nature of Sample.	Dissolved Solids. Mineral.	Dissolved Solids. Organic.	Total Dissolved Solids.	Suspended Solids. Mineral.	Suspended Solids. Organic.	Total Suspended Solids.	Total Solids.
160	9/3/93	Samples from beating and washing machines taken every five minutes and mixed.	152·2	110·5	262·7	32·1	63·9	96·0	358·7
161	9/3/93	Samples from breaking and washing machines taken every five minutes and mixed.	18·6	18·3	36·9	8·1	29·8	37·9	74·8

These effluents are subject to the same remarks as bleacher's uncoloured effluent in the main, and certainly so far as treatment is concerned.

Upon being mixed with iron sulphate and lime a decided deposition of solids takes place quickly and a clear supernatant effluent is obtained. If such treatment and the recovery of soda were insisted upon, the river Darwen would soon present a very altered appearance for the better.

Soda Recovery.

Just as the dyer adds an excess of colouring matter in the becks over what is required for absorption by the fabric, so does the paper-maker add an excess of soda in his boiler, and to the same end, namely, acceleration of the action desired, and thus a saving in the cost of running machinery and an increased output. But this excess of soda added is something very considerable. The strength of the caustic lye first added is about 10° Twaddell, is reduced in boiling to about 4° Twaddell, and then further reduced to 2° by the addition of wash water.

A sample of waste soda lye and wash waste at 2° T. from Dimmock's, March 9th, 1893, contained 145grs. per gallon of soda. This soda is of course in solution, and side by side with other foreign matters both in solution and suspension. It can be recovered by evaporating the water and burning off the foreign matter from the residue after evaporation.

An evaporator cannot be judged efficient or otherwise according to the amount of soda put out. This depends upon the amount and strength of the soda ash primarily placed in the causticiser, and also upon the nature of raw materials boiled. Such materials as flocks and rags, containing comparatively large quantities of fatty matters, take naturally more soda, weight for weight, than straw and esparto, for saponification.

The percentage of soda in the ash recovered also must depend upon the amount of dirt and fibre in the waste liquor, these latter being more abundant in liquors from the boiling of flocks, rags, and bagging, than in those from the boiling of straw, esparto, or grass.

Hence a very efficient evaporator may be running nearly at a loss in one mill and a less efficient evaporator making a profit at another, though both are very important factors in the prevention of rivers pollution.

Many different methods of evaporation are practised, but the most recent and perhaps the most scientific is the "Chapman."

The distinguishing feature of this evaporator is that the liquors are evaporated at a reduced pressure or partial vacuum maintained by an air pump. This partial vacuum lowers the boiling point of the liquor. Further, it is claimed that the air pump and all other incidental pumps or machinery are run by power raised from steam generated by the liquor itself, which is first run into a steam boiler.

At Messrs. Dimmock's it was found the generation of steam from the liquor itself was a failure, as the excessive incrustation in the boiler brought down the flues. There is more than the usual amount of fibre in Messrs. Dimmock's waste lye.

On testing the evaporator March 9th, 1893, the strength of liquor running into pans was 2° Twaddell, at a temperature of 90° F., and contained 145 grains of soda per gallon.

The strength of the liquor running out of the pans was 42° Twaddell, at a temperature of 100° F., and contained 5,600 grains of soda per gallon.

From Messrs. Dimmock's weekly return* ·276 tons of coal are used per hour in the furnaces for incinerating the liquor after evaporation, but for running the evaporators three small engines were required.

The first, for pumping liquor into pans, of which the I.H.P. on date of trial was 2·1.

The second, for maintaining vacuum in pans, pumping water for condensing purposes, etc., I.H.P. 35·3.

The third, for pumping liquor from evaporating pans into incinerating furnaces, I.H.P. 2·3. Total I.H.P., 39·7.

Coal used per hour at 4lbs. per I.H.P. equals 158·8 lbs. per hour. This gives for the whole of the plant ·283 tons of coal per hour, or 4,155 gallons of liquor per ton of coal. It also brings up the total coal used per 122 hours (see Messrs. Dimmock's return) to 34·5 tons, or one ton of ash per 3·45 tons of coal.

One ton of ash before being used is valued at £5, but the recovered ash is one-third below strength in this case.

To the matter given above must be added the interest on capital for plant, depreciation and running expenses, the profit or loss depending, as before pointed out, upon the nature of initial waste liquor. The figures given, too, are to be taken for purposes of this report, and not as a strictly scientific calculation, upon which the system may

* One Week's Working Averaged.

Time.	Strength.	Total galls.	Coal.	Ash recovered.
122 hours	Twaddell at 60° F. 6 in, 44 out.	143,565	33·75 tons	10 tons.

Appendix 2.

be condemned or otherwise in comparison with any other.*

Nevertheless, it can easily be calculated from these data that this "Chapman" evaporator is strong in the pans but weak in the incinerator or roaster.

It is very important that an incinerator be laid down on the best possible lines, for the denser a liquor becomes, the more the heat required to evaporate a given quantity of waste from it. I have italicised the latter portion of Mr. Goodall's statement to illustrate this point.

Another popular form of evaporator is the "Porion," now in use at Messrs. Peebles', Rishton, a detailed description of which accompanies this report, as one also of the "Chapman." As an incinerator pure and simple it is questionable whether there is anything at present to beat this, though in the earlier stages no advantage is taken of the diminished temperature at which all liquids boil *in vacuo*. The two compare thus:

—	Tons of coal per ton of ash recovered.	Gallons of liquor per ton of coal.
Chapman (Dimmock's)	3·45	4,155
Porion (Peebles') -	1·6†	2,498

Seeing then that one is weak where the other is strong, and *vice versâ*, the most reasonable course appears to be a combination of the two, each at a reduced size.

There are no figures given in Mr. Davis's paper on the Porion evaporator, read before the Scottish Paper Makers' Association, November, 1888, from which the amount of coal can be calculated which would be required to reduce liquors from, say, 2° T. to 40° T. (100° F.), the point at which they virtually enter the incinerator proper, nor do I know of any means whereby this could be calculated in practice, for it would probably be contended that the reduction was brought about by waste heat in the Porion. But the tendency will be to make liquors weaker and weaker by washings in the future, to prevent river pollution, and it appears to me that a point may be reached beyond which it would be more economical to resort to multiple effect evaporation for the earlier stages, than to extend the evaporating end of the Porion to a point where it would be almost cold. This is evidently Mr. Davis's opinion as expressed in the paper referred to above:—

"In the early days of soda recovery the lyes evaporated in paper mills and other factories were very strong, the weaker liquors being turned into the nearest streams, but the continual desire to prevent the pollution of our rivers has led to weaker lyes being evaporated. The subject comes to us therefore under a new set of conditions. Manufacturers may be inclined to ask whether these altered conditions have changed our views with regard to the efficiency of the Porion system? Our reply will, we hope, be clear and definite when we say, *Give a Porion evaporator liquor at 10° Tw. and 100° F. and it will 'beat the record,' for profit, of any existing evaporator.* If there is any merit in multiple evaporation, and we believe there is, *up to a point*, it would be in so arranging the plant that all the strong liquor is treated direct in a Porion, the weaker liquids being concentrated to 10° Tw. at 100°. F., and then handed over to the Porion to finish.

"Under any system of recovery, furnaces, or calciners, are required: the Porion chamber is simply an addition to these, and is by no means costly in itself, and will stand for many years without repairs. Multiple evaporation has been heretofore clouded with too many specious statements; it is too often overlooked that expensive furnaces are required beside the multiple-effect stills and the steam boilers necessary to supply them with steam. Nevertheless, it is often a decided economy to employ multiple effect stills, as we have said before, up to a certain point, and that point is a concentration to 10° Tw. at 100° F."

Weekly statement from Peebles' *re* Porion evaporator:

Time.	Strength.	Total galls.	Coal.	Ash recovered
132 hours	Twaddell at 113°F. 6·2.	46,962	18·8 tons	11·05 tons.

But whatever system of evaporation be adopted, that soda can be recovered without financial loss and that no hardship would be endured by any manufacturer if this were insisted upon, has been, I think, fully proved.

EXTRACT FROM "WATT ON PAPER MAKING" (p. 49).

"The liquor resulting from the boiling of esparto, which is of a dark brown colour, contains nearly all the soda originally used, but it also contains silicious, resinous, and other vegetable matter which it has dissolved out of the grass, the silica taking the form of silicate of soda. The esparto liquor, which was formerly allowed to run to waste, polluting our rivers to a serious extent, is now treated by several ingenious methods for the recovery of the soda, with considerable advantage alike to the manufacturers and the public. The process consists essentially in boiling down the liquor to dryness and incinerating the residue. During the process of incineration, the carbonaceous matter extracted from the grass is converted into carbonic acid, which, combining with the soda, re-converts it into carbonate of soda, which is afterwards causticised with lime in the usual way, and the caustic soda thus obtained is again used in the boiling of esparto. Although one or other of the recovery processes is adopted at a good many of our paper mills, the recovery of soda is by no means universal as yet, but the time will doubtless soon arrive when the economical advantages of the process will be fully recognised. Indeed, we know it to be the fact that some manufacturers are watching, with keen interest, the progress of some of the newer systems of soda recovery, with the full intention eventually of adopting one or other of them."

The return appended has been supplied by papermakers in the Ribble Basin. The names of firms are not given, as the information was to be considered private in some instances. Additions have been made since the return issued in March, 1892.

FOURTH.—TANNING.

As, up to date, only four tanneries have been reported in the district, draining into natural watercourses directly, and as one of the these is to be coupled up with sewers under an order of the County Court, it will not be requisite that a complete account of the trade should be detailed.

Suffice it to say that the refuse from tanneries is of a highly offensive character, due to the animal matter it contains from the washing and soaking of skins.

"Beside considerable quantities of ammonia, old limes contain tyrosin, leucin or amidocaproic acid and some caproic acid, the disagreeable goaty odour of which is very obvious on acidifying an old lime liquor with sulphuric acid, by which considerable quantities of a partially altered gelatin are at the same time precipitated. Very old limes, especially in hot weather, often contain active bacteria, which may be seen in the microscope under a good $\frac{1}{4}$ inch objective. Their presence is always an indication that putrefaction is going forward. . . . It is probable that in many tanneries the ammonia would pay for recovery from the lime liquors, which would be easily done by steaming the old limes in suitable vessels, and condensing the ammoniacal vapours in dilute sulphuric acid. (Some appliances suitable for this purpose are described in the Journal of the Soc. of Chem. Industry, III., 630)."

H. R. PROCTOR, F.C.S., on Tanning.

* Mr. Goodall, the Manager of Hendon Paper Works, Sunderland, gives the following particulars of the actual work performed by a Chapman evaporator: — 200,000 gallons of black liquor of $5\frac{3}{4}$ T. at 160°F. are reduced to 29,370 gallons of thick liquor of $46\frac{1}{2}$T. at 125°F. ready for the roasters, by an expenditure, of 20 tons 11 cwts. 3 qrs. of small coal, equivalent to an evaporation of 37 lbs. of water per pound of coal used, and to $10\frac{1}{2}$ cwt. coal per ton of ash recovered, *without counting the coal used at roaster.* (Own italics.)

† In comparing these figures it is very important to note the difference in strengths of initial liquor. There is apparently no wash water admitted at Peebles, and esparto is the principal raw stuff.

Appendix 2.

The Rivers Pollution Commissioners reported:—

"The waste liquors from tanneries may, for all practical purposes, be regarded as concentrated sewage, possessing from five to ten times the manure value of the latter. These liquors would, therefore, form an acceptable contribution to the contents of town sewers, when the sewage is applied to irrigation. If this were impracticable, owing to the tannery being situated in the country, there could be no difficulty in disposing of these valuable liquids upon the neighbouring land. Or, lastly, they might be sufficiently purified to be admissible into streams by downward and intermittent filtration through sand or porous soil."

There is just a possibility of the three remaining tanneries being connected with town sewers (Colne), but if this is not done, precipitation and filtration should certainly be resorted to.

Fifth.—The Manufacture of Alkali and Various Chemicals.

Other than solid refuse the only polluting agents from alkali works is the drainage from old waste tips. Quoting from my report in May last, page 8, Proceedings Ribble Joint Committee:—I cannot do better than quote from the report of Mr. Fletcher, Chief Inspector to the Local Government Board, under the Alkali Works Regulation Acts Report for the year, 1888, to the Chief Secretary for Scotland.

"The 'tank waste' or 'vat waste' of the Leblanc process is the residuum after the lixiviation of the 'black ash' or crude soda. It consists mainly of calcium sulphide, and is liable to oxidation and a decomposition, which causes the generation of sulphuretted hydrogen, so that the material, unless protected from the air, speedily becomes highly offensive. As, moreover, this waste is produced in large quantities, there has always been great difficulty in disposing of it. In the neighbourhood of some alkali works it is to be seen in almost mountainous masses, occupying valuable space, and if not giving off offensive gases, yet yielding a drainage which is a source of great nuisance."

This waste contains about 15 per cent. sulphur when fresh from the lixiviation tanks, but important changes take place when left exposed to the atmosphere. It is now about 20 years since the finishing touch was given to this tip in the shape of a covering of soil and crop of grass. Meanwhile most of the sulphides have drained away into the brook, and portions are so continually draining into it, either as sulphides or other soluble sulphur compounds. But in whatever form the sulphur enters, a nuisance is bound to be created, for the Douglas at this point holds in solution an extraordinary amount of carbonic acid, due to the decomposition of unpurified sewage or sewage effluents from Horwich, Blackrod, Adlington, Ince-in-Makerfield, Standish, Aspull, Pemberton, Billinge, and other centres of population higher up. The drainage also contains sulphydrates and sulphides, as well as hypo-sulphites, and though in small amounts (only ·1 per cent. of the former, and ·06 per cent. of the latter), in amounts sufficiently large to be far too perceptible.

The action of the carbonic acid on sulphydrates and sulphides of lime is to produce sulphuretted hydrogen and carbonate of lime; on hypo-sulphites, sulphurous acid is generated and sulphur precipitated.

The result is that the river on nearing the drainage outlets is turned milky white, in its ordinary course, and in the absence of this drainage in dry weather the diminished volume of the river is blackened by unpurified sewage and manufacturing refuse.

It is therefore very desirable that steps be taken to prevent the entrance of this liquor into the river, though it is not sufficiently rich in sulphur to pay for its recovery. Its strength is less than 1° Twaddell, whereas liquors similar in other respects, but of 5° or 6° Twaddell, are permitted a second percolation through the heap for concentration, before being used in the Chance Claus process, and then not for recovery directly but only instead of water for lixiviating fresh tank waste, to go into the carbonators.

There are, nevertheless, means available whereby this drainage can be rendered harmless, and since the pollution may continue many years under present circumstances (a sample of the waste contained ·2 per cent. of oxidisable sulphur only 2 feet from the surface) some means should certainly be adopted.

Sample 21. Analysis of Tank Waste on Canal Embankment and Banks of Douglas at Parbold. Taken at a depth of 2 feet. April 20th, 1892.

Moisture at 212° F.	45·924
Sand	4·384
Carbon	2·326
Silica (combined)	0·782
Iron Sulphide	2·039
Alumina	0·926
Carbonate of Lime	27·832
Sulphate of Lime	14·944
Sulphide of Lime (all oxidizable sulphur calculated as such)	0·658
	99·815

Sample 22. Drainage from Waste or Yellow Liquor.

	Total Solids	558·1 grs. per gal.	
	Total Sulphur	265·7 „ „	or 0·37%
Objectionable.	Sulphur as Calcium Sulphide (CaS).	82·1 „ „	„ 0·11%
	Sulphur as Hypo-Sulphite.	43·7 „ „	„ 0·06%
	Specific Gravity	1·004	

Carbonic Acid in Solution in River Douglas.

Sample No.	Point.	Total Dissolved Gases at Normal Pressure and Temperature.	Carbonic Acid in Total Gases.
30	Source above Horwich.	19·5cc. per litre	0·98cc. per litre.
31	Near Alkali Tip at Newbold.	19·7cc. per litre	5·6cc. per litre.

The yellow liquor (Sample 22) could be treated by Chance's process of sulphur recovery, though not with any hope of profit, for since the total oxidisable sulphur amounts to only 125·8 grains per gallon, 120,000 gallons would need treating to obtain a ton of sulphur, value five pounds. To carry by rail 120,000 gallons weighing 500 tons to the nearest plant is out of the question, while the suggestion of putting down plant on the spot to treat a liquor limited in quantity and continually decreasing in strength is still more absurd.

But it might be treated with little and gradually decreasing cost by means of ferric chloride. If this salt be added to the liquor, a precipitate of iron chloride is formed, which could be collected and sold to sulphuric acid makers, and the clear liquor run into the rivers. No disagreeable smell accompanies this treatment as at present exists, and the amount of ferric chloride necessary for treatment would diminish with the diminution of oxidisable sulphur in the liquor, and in time die out altogether.*

Alkali drainage might also be used as depilatory in the process of tanning in virtue of the sulphides present, for although small in quantity they could be brought up to strength. At one time sodium sulphide was made from tank waste by Messrs. Gamble, St. Helens, under Schaffner and Helbig's patents, but I cannot say whether this has been recently discontinued in favour of the recently invented Sulphur Recovery Process.

The Hyndburn Brook, at Church, is banked on both sides by high masses of alkali waste, tons of which are continually falling into it. The drainage from this tip emits large quantites of sulphuretted hydrogen, especially when entering the brook and coming in contact with the acid bleach waste from about eight or nine works less than two miles away up stream.†

* Iron salts in almost any form might be used. Mr. Ballard, Inspector of Alkali Works, informs me that were it not for iron salts draining into the Sankey Brook, at St. Helens, that now famous stream would be in a much worse condition than it is even.

† A bleaching mill formerly running close to the river was shut up, owing to damage to fabrics by machinery marks. The machines were attacked by gases arising from brook.

Appendix 2

VARIOUS CHEMICALS.

Soap.

As mentioned earlier, common soap is a combination of alkali and fatty acid.

The soap-boiler boils alkali and neutral fat—*not fatty acid.* A neutral fat consists of a fatty acid in combination with glycerin. When, therefore a neutral fat is boiled with an alkali soap is formed, by the combination of alkali and fatty acid, while the glycerin is left in the mother liquor.

In order to effect the readier separation of soap from the mother liquor common salt is added. This mother liquor may contain, according as to whether white or black soda ash used :—

Glycerin, common salt, sulpho-cyanides, cyanides, sulphides, albuminous, resinous, fatty, colouring, and other organic matter. On a large scale the glycerin is recovered, but it is not at present in the smaller soap factories. The number of these in the Ribble basin supplying soap to the print mills and cotton mills for size is very considerable, the effluents therefrom being, to say the least, most abominable.

For making the cheaper class of soaps dirty raw materials are often used, the dirt from which, for the most part, enters the river with the mother liquor.

"From soap factories there issue as refuse waters the mother liquors (*unterlaugen*, lit. under lyes) which remain at the unsalting of the curd, and which contain in the main common salt, glycerin solution, with generally a small quantity of caustic soda, the exact quantity of which has already been fixed by the economy of the factory management. A soap factory which produces daily 500 kilos of curd soap, supplies about 2 c. metres of lyes as refuse which may contain from 5 to 20 per cent. common salt."—(Fleck, 12th and 13th reports of the "Chemischer Centralshelle Zu Dresden.")

Sample of mother liquor entering Hyndburn Brook from H. Bury, jun., and Co., Church, 10/3/93, No. 162 :

Organic matter	6,232·0 parts per 100,000,	or 6·2 per cent.
Mineral matter	8,810·0 ,, ,,	or 8·8 ,,
Total solids	15,042·0 ,, ,,	or 15 ,,
Caustic soda	120·0 ,, ,,	or ·12 ,,
Glycerin	1,009·0 ,, ,,	or 1 ,,
Fat	6,984·0 ,, ,,	or 6·9 ,,
Chlorine, equal to common salt	5,302·0 ,, ,,	or 5·3 ,,

A fatty scum often arises from the soap pans in emptying mother liquor, which is skimmed into a tank and allowed to drain.

Sample of such drainage from H. Bury, jun., and Co., Church, 2/3/93, No. 163 :—

Organic matter	242·0 parts per 100,000.
Mineral matter	532·0 ,, ,,
Total solids	774·0 ,, ,,
Fatty anhydrides	1,272·0 ,, ,,

Tallow, Machine Oil, Waggon Grease, etc.

Suet, tripe cuttings, slaughterhouse offal, and other substances containing fat are boiled with acid, when the fatty acids rise to the surface, leaving below a very foul liquor for an effluent.

Sample from Bridge, Baron, and Co., Church, 10/3/93, No. 164 :—

Mineral matter	1,682·0 parts per 100,000.
Organic matter	4,514·0 ,, ,,
Total solids	6,196·0 ,, ,,
Acidity	12 parts per 100 Normal Soda required.
Fatty anhydrides	1,166·0 parts per 100,000.

Effluents from three last-named processes should be freed from any unused fat, soda, or acid in working, and afterwards treated by precipitation and filtration.

Preparation of Indigo Extracts.

Different preparations of indigo are made for use in different mills, chiefly by means of acids. For example, sulpho-purpuric acid or indigo purple is made by mixing indigo and sulphuric acid and heating the mixture, after which the purple is precipitated upon mixing with water. It is then filtered through cloths and washed with weak hydrochloric acid.

Filtrate from H. Bury, Jun., and Co., Church, 10/3/93, No. 165, gave—

Mineral matter	1,816·0 parts per 100,000.
Organic matter	1,798·0 ,, ,,
Total solids	3,614·0 ,, ,,
Acidity	9 parts per 100 Normal Soda required.

This effluent ought to be neutralised and submitted to precipitation and filtration.

An agent could probably be found which would neutralise and precipitate at the same time. There are many other obnoxious chemical effluents entering the river from tar distilleries, glue works, etc., space for the consideration of which cannot be found here, but which can be dealt with later, on their merits.

General Solid Refuse.

At Messrs. Blythe and Co.'s, Church, zinc chloride, for size, is made by dissolving zinc in hydrochloric acid. Any iron in the solution is liberated as oxide by means of chlorate of potash, and when so liberated is skimmed off and allowed to run into the river.

This might be dried and sold as a pigment. The same thing occurs in the manufacture of zinc sulphate.

I have also seen in various towns thrown on to the river bed, lime from cauticisers, chloride of lime dregs from making bleaching solutions, carbonised matter from soda recovery incinerators, calico printers' waste thickenings, pickings from esparto, tub washings, rubbish collected by water wheel screens, and even precipitated sludge.

It is a very difficult matter to trace these acts of misdemeanour right home. They are the work of a moment only, and though some good may be done by making an occasional example, it is a question whether the practice can be stopped except by moral suasion.

More I think could be accomplished by asking the manufacturers to meet the Committee to discuss these matters, and to co-operate with the Committee, all working from one centre.

Certain points are often raised, such as the building of retaining walls jointly, acquisition of land, the formaton of contributory areas, the adoption of standards, power of entry, the meaning of innocuous discolorations, etc., which want thoroughly thrashing out, and before any further steps are taken with the notices given, I would suggest that the parties concerned be asked to meet the Committee and state their views.

I cannot conclude without expressing my obligation to the firms mentioned in the Report for the samples supplied, and for the very kindly spirit in which they have assisted with any information asked for in connection with it, often with a great amount of trouble.

The following firms have also supplied samples, etc. :

Messrs. The Spring Valé Paper Company.
,, ,, Star Paper Company.
,, ,, Sabden Print Company.
,, W. N. Wilson and Sons.
,, John MacKenzie and Co.
,, Riley and Co., Hapton.

I am, Gentlemen,
Your obedient servant,
Wm. Naylor.

STATISTICS—*RE* PAPER MILLS IN RIBBLE WATERSHED.

Number.	Quantity of Water used per Day, in Gallons.	Source of Supply, River or Private.	Quantity of Soda used per Annum, in Tons.	Quantity of Soda recovered per Annum, in Tons.	Quantity of Bleaching Powder used per Annum, in Tons.	Raw Materials used per Annum.					Wood Pulp.		Kinds of Paper made.
						Straw and Esparto used per Annum, in Tons.	Rags used per Annum, in Tons.	Peat used per Annum, in Tons.	Surat Bags used per Annum, in Tons.	Waste Paper used per Annum, in Tons.	Mechanical used per Annum, in Tons.	Chemical used per Annum, in Tons.	
1	500,000	Private	620	All—380	350	3,500	1,400	—	—	—	6,000	600	News.
2	400,000	Private	780	—	600	3,000	1,800	—	—	—	200	200	News.
3	60,000	River	15	None	25	100	—	—	600	—	150	150	Cap.
4	200,000	Private	—	—	30	—	—	—	1,600	—	—	—	Cap.
5	100,000	River	—	—	—	—	—	50	500	400	—	—	Brown and shop.
6	500,000	Private	700	None	—	3,000	1,200	—	—	300	2,500	—	News and stainers.
7	1,000,000	River	800	All	—	4,000	2,800	—	—	600	4,500	—	News.
8	20,000	River	12½	None	12	—	26	5	—	20	38½	—	Brown.
9	1,000,000	Private supply	1,000	341	350	4,065	2,708	—	—	280	1,357	319	Stainers and shop.
10	24,000	River	2	—	—	—	—	30	—	300	—	—	Brown.
11	600,000	River and private	28	None	35	None	440	—	620	1,450	5	—	Brown and groceries.
12	60,000	River	40	—	7	—	900	600	1,000	780	—	—	Brown.
13	200,000	Private	300	250	400	2,500	20	None	None	None	None	850	Printings.
14	400,000	Private	300	250	600	2,000	None	None	None	None	1,000	2,000	News and printings.
15	250,000	Private	50	None	20	—	1,000	—	—	—	—	17½	Writings and account book papers.
16	200,000	Private	6¼	None	About 25° Carb., 21° Twad. liquor	—	500	—	—	300	—	50	Fine browns, wrappers, and G. W. bag papers.
17	24,000	River and Private	2	—	2	—	12	10	240	400	—	5	Brown.
18	500,000	Private account	100	—	20	—	20	10	2,000	2,000	—	—	Brown and groceries.
	6,038,000		4,755¾	1,221	2,451	22,165	12,826	705	6,560	6,830	15,750½	4,191½	

APPENDIX No. 3.

Handed in by Mr. R. A. Tatton, M.I.C.E.

MERSEY AND IRWELL WATERSHED.

Particulars as to the methods of Sewage Treatment adopted by the Local Authorities in the Mersey an

Note.—The samples have been taken over a period of two years, 1897-98

NAME OF AUTHORITY.	Population.	Population connected up. 1.	Estimated Quantity of Sewage in 24 hours. 2.	Character of Trade Waste in Sewage. 3.	Number of Precipitation Tanks and Total Capacity. 4.	Precipitant used. 5.	Quantity of Precipitant used per Week. 6.	Number of filters and Total Area. 7.
CHEMICAL PRECIPITATION ALONE.								
(A) Domestic Sewage only.								
Milnrow Urban District Council	8,600	8,000	About 200,000 gallons.	—	3 tanks, each 100ft. by 30ft. by 6ft. Total capacity, 337,500 gallons.	Alumina ferric	5 to 7 cwt.	—
(B) Sewage Mixed with Trade Waste.								
Bolton Corporation	115,000	130,000 (Borough, 115,000; rural, 15,000.)	5,000,000 gallons	1 tannery, 9 breweries, 2 dye works.	2 detritus tanks, 2 settling tanks. Total capacity, 4,000,000 gallons.	Lime, alumina ferric.	Lime, 28 tons; alumina ferric, 8¾ tons.	None
Manchester Corporation	536,000	514,960	About 22,000,000 gallons.	Print works, dye works, bleach works, brewery, tanneries, chemical works, galvanising works.	11 tanks, each 300ft. by 100ft. by 6ft. (average depth). Total capacity, 12,375,000 gallons.	Milk of lime and solution of copperas.	50 to 70 tons of copperas, and from 60 to 100 tons of lime.	None constructed at pre sent, with the exceptio of some small experimen tal filters.
Salford Corporation	198,000	198,000	Dry weather flow, 9,000,000 gallons.	Dye works, bleach works, breweries, print works, paper works.	12 tanks, each 110ft. long by 77ft. wide. Total capacity, 5,250,000 gallons.	Lime	About 80 tons	Filtration works are nov in course of constructior
Whitefield Urban District Council	5,800	5,000	Average 350,000 gallons per day.	4 dye works, 1 brewery.	10 tanks. Total capacity, 140,000 gallons.	Alumina ferric	Average 1 ton	—
Kearsley Urban District Council	8,000	6,370	127,400 gallons	2 dye works	3 tanks, each 89ft. by 35ft. by 5ft. 9in. Total capacity, 335,811 gallons.	Alumina ferric	About 9 cwt.	6 filters. Total area, 48 square yards; 261 gallon per square yard.
Farnworth Urban District Council	23,758	23,158 (All connected, except 600 rural.)	About 560,000 gallons dry weather flow.	1 dye works, 1 brewery.	3 tanks, each 160ft. by 50ft. by 9ft.; 2 tanks, each 100ft. by 28ft. by 9ft. Total capacity, 1,665,000 gallons.	Lime and sulphate of iron.	About 5½ tons per week.	None
Prestwich Urban District Council	10,469	8,000	452,504 gallons	2 dye works	9 tanks. Total capacity 606,010 gallons.	Alumina ferric	1 ton 6cwt. 3qrs.	4 filters. Total area, 92 square yards; 489 gallon per square yard.
PRECIPITATION AND ARTIFICIAL FILTRATION.								
(C) Chemical Precipitation and Rapid (Mechanical?) Filtration.								
Domestic Sewage only.								
Ashton-in-Makerfield Urban District Council.	900	900 (Including 156 from adjoining district of Abram.)	Quantity varies from 5,000 to 15,000 gallons.	—	3 tanks. Total capacity 15,000 gallons.	Alumina fer.ic	140 to 200lbs.	3 filters. Total area. 3 square yards; 285 gallon per square yard.
Atherton Urban District Council (Glasshouse).	16,500	7,500	66,000 gallons	—	3 tanks. Total capacity 426,000 gallons.	Lime and alumina ferric.	17·05cwt. of lime and 4·45cwt. alumina ferric.	None
Atherton Urban District Council (Hindsford).		6,800	60,000 gallons	—	6 tanks. Total capacity 210,000 gallons.	Lime and sulphate of iron.	3½cwt. sulphate of iron and 1·05cwt. of lime.	Total area, 100 squar yards; 600 gallons pe square yard.
Cheadle and Gatley Urban District Council.	8,200	6,000	About 200,000 gallons.	—	6 tanks. Total capacity 222,000 gallons.	Alumina ferric	Average 16cwt. 1qr.	Total area, 320 squar yards; 625 gallons pe square yard.

Note.—The term rapid filtration implies that the liquid is not held up in the filters over lengthened periods, as is the case with the biological filters, but is passed more or less rapidly through them.

APPENDIX No. 3.

Handed in by Mr. R. A. TATTON, M.I.C.E.

MERSEY AND IRWELL WATERSHED.

Irwell Watershed, derived from information supplied by the Authorities to the Joint Committee.

The limit of impurity is one grain per gallon of oxygen absorbed in four hours.

Depth and Character of Filtering Material. 8.	Method of using Filters (whether Intermittent or Continuous). 9.	Area of Land used for Filtration or Irrigation. 10.	Rate of Filtration in Gallons per Acre. 11.	Additional Area of Land owned but not used for Filtration. 12.	Sludge: How Disposed of. 13.	Number of Samples Below Limit.	Number of Samples Above Limit.	Total Samples.	Percentage of Samples Below Limit.	REMARKS.
—	—	7½ acres, only lately brought into use.	—	1½ acres - -	On land - - -	–	6	6	100	When the samples were taken, only a small proportion of the sewage was connected to the works.
None - - - - -	—	150 acres being now laid out into filtration plots. Subsoil land, loam, sand, and gravel, and land drained 6ft. deep. Plots to be worked intermittently.	—	—	Air-dried, and given away to farmers and others.	7	-	7	-	Samples are from tank effluent. Under an order of Court to construct further filtration works.
—	—	26¼ acres - - -	—	139¼ acres, including site of buildings, tanks, roadways, &c.	Sludge taken out to sea	29	–	29	–	Under an order of Court to construct further filtration works.
—	—	—	—	Total area of site, 34 acres.	Sludge taken out to sea	28	–	28	–	Under an order of Court to construct further filtration works.
—	—	3½ acres in course of preparation for use as filters.	-	1½ acres, on which are the tanks, buildings, &c.	—	3	4	7	57	-
2ft. 9in. of coke and cinders.	Intermittent -	Not yet in use - -	1,263,240	—	Given to farmers - -	4	2	6	33	The samples were taken before the filters were brought into use.
—	—	None - - - -	—	Total area of land at works, 10¾ acres.	Carted away by farmers	9	–	9	–	A scheme is before the L. G. B. for filters.
1 filter, sand, cinders, and stone. 2 filters, cinders, 3ft. deep.	Continuous - -	None - - - -	2,366,760	None - - -	Taken away by farmers	3	3	6	50	The samples were taken before the filters were brought into use.
Total depth about 3ft., made up as follows:—12in. sand, 12in. sand and polarite equal parts, 5in. sand and 4in. gravel, 3in. stone and agricultural tiles.	Intermittent -	About 4 acres; 2,500 gallons per acre.	1,379,400	- -	Used on the land by the farmers.	1	4	5	80	—
—	—	½ acre - - -	132,000	—	Carted away by local farmers.	–	4	4	100	These outfalls have been done away with, and the Atherton sewage taken to the Leigh works.
Gravel and sand, 2ft. 6in. deep.	—	1½ acres; 40,000 gallons per acre.	2,904,000	-	Carted away by local farmers.	4	1	5	20	
Sand, gravel, and polarite	—	The effluent is at times pumped on a plot of about 4½ acres of gravel land; 44,444 gallons per acre.	3,025,000	--	Pressed, and removed by local farmers, who take it readily.	-	11	11	100	—

MERSEY AND IRWELL WATERSHED—*continued.*

PARTICULARS as to the methods of Sewage Treatment adopted by the Local Authorities in the Mersey and

NAME OF AUTHORITY.	Population.	Population connected up.	Estimated Quantity of Sewage in 24 hours.	Character of Trade Waste in Sewage.	Number of Precipitation Tanks and Total Capacity.	Precipitant used.	Quantity of Precipitant used per Week.	Number of Filters and Total Area.
		1.	2.	3.	4.	5.	6.	7.
PRECIPITATION AND ARTIFICIAL FILTRATION—*continued.*								
(c) CHEMICAL PRECIPITATION AND RAPID (MECHANICAL ?) FILTRATION—*continued.*								
DOMESTIC SEWAGE ONLY—*cont.*								
Crompton Urban District Council (Cowlishaw).	12,900	1,500	37,500 gallons	—	2 circular tanks, each 14ft. diameter, 9ft. deep. Total capacity 17,318 gallons.	Ferozone - -	5½cwt. - - -	4 filters. Total area, 13 square yards; 282 gallons per square yard.
Crompton Urban District Council (Newhey).		8,000	200,000 gallons	—	3 tanks, each 50ft. by 40ft. Total capacity 225,000 gallons.	Alumina ferric -	15cwt. - - -	6 filters. Total area, 760 square yards; 263 gallons per square yard.
Failsworth Urban District Council - -	13,000	13,500	Between 380,000 and 500,000 gallons.	—	2 detritus tanks, 6 upward-flow tanks and 2 precipitation tanks. Total capacity 677,000 gallons.	Alumina ferric; now trying other precipitants.	About 30cwt. per week.	6 filters. Total area, 960 square yards; 458 gallons per square yard.
Heaton Norris Urban District Council -	9,010	8,600	255,000 gallons	—	2 tanks. Total capacity 280,000 gallons.	Alumina ferric -	15cwt. per million gallons.	4 filters. Total area, 410 superficial yards; 621 gallons per square yard.
Knutsford Urban District Council - -	5,300	5,300	164,000 gallons	—	3 tanks. Total capacity 291,000 gallons.	Alumina ferric -	Average 27cwt. -	6 filters. Total area, 142 square yards; 1,154 gallons per square yard.
Little Lever Urban District Council -	5,500	5,000	140,000 gallons	—	3 tanks. Total capacity. 421,875 gallons.	Lime and copperas.	10½ cwt. of lime, 10½ cwt. of copperas.	3 filters. Total area, 290 square yards; 482 gallons per square yard.
Littleborough Urban District Council -	10,900	8,300	270,000 gallons		4 tanks. Total capacity, 350,000 gallons.	Alumina ferric -	About 10 cwt. -	2 filters. Total area, 290 square yards; 931 gallons per square yard.
Little Hulton Urban District Council -	7,000	860 4-5ths is treated by the Worsley U.D.C., at their Sewage Filtration farm at Barton Old Hall.	4,300 gallons	—	Long channel. 8 tanks, each 18 ft. by 13 ft. 10 in. by 5 ft. Total capacity, 62,248 gallons.	None - - -	None - - -	Total area, 250 square yards; 17 gallons per square yard.
Marple Urban District Council - -	4,800	3,700	80,000 gallons	—	4 tanks. Total capacity, 151,875 gallons.	Alumina ferric -	12 cwt. - - -	4 filters. Total area, 611 square yards; 130 gallons per square yard.
Norden Urban District Council - -	3,900	1,282	40,000 gallons	—	4 tanks. Total capacity, 15,000 gallons.	Alumina ferric -	3½ cwt. - - -	2 filters. Total area, 75 square yards; 533 gallons per square yard.
Royton Urban District Council - -	13,400	9,500	About 450,000 gallons.	—	6 tanks. Total capacity, 543,240 gallons.	Alumina ferric -	Average, 3,062 lbs. per week.	8 filters. Total area, 800 square yards; 562 gallons per square yard.
Turton Urban District Council - -	6,500	About 5,000	195,000 gallons dry weather flow.	—	3 tanks. Total capacity, 195,000 gallons.	Lime and copperas.	10 cwt. lime and 2 cwt. copperas, Sundays and nights excepted, when alumina ferric is used.	2 filters. Total area, 182 square yards; 1,071 gallons per square yard.
Tyldesley (with Shackerley) Urban District Council.	14,500	13,300	300,000 gallons	—	2 tanks, subdivided into 32	Alumina ferric; but contemplating using copperas and lime.	1 ton of alumina ferric.	8 filters. Total area, 500 square yards; 600 gallons per square yard.
Wardle Urban District Council (Higher Works).	3,900	1,500	30,000 gallons	—	1 circular tank. Total capacity 80,000 gallons.	Alumina ferric -	4 cwt. - - -	2 filters. Total area about 55 square yards; 545 gallons per square yard.
Wardle Urban District Council (Lower Works).		2,000	40,000 gallons	—	1 circular tank. Total capacity 80,000 gallons.	Alumina ferric -	7 cwt. - - -	2 filters. Total area about 33 square yards; 1,212 gallons per square yard.
Barton Rural District Council (Clifton) (portion of).	—	1,600	24,000 gallons	—	1 tank. Total capacity 1,800 gallons.	Alumina ferric and milk of lime.	4½ cwt. - - -	Total area, 1,200 square yards; 20 gallons per square yard.
Bolton Rural District Council (Belmont) (portion of).	—	720	38,000 gallons	—	3 tanks. Total capacity 21,469 gallons.	Alumina ferric -	About 60 lbs. - -	1 filter. Total area 220 square yards; 172 gallons per square yard.

MERSEY AND IRWELL WATERSHED—*continued.*

Irwell Watershed, derived from information supplied by the Authorities to the Joint Committee—*continued.*

Depth and Character of Filtering Material. 8.	Method of using Filters (whether Intermittent or Continuous). 9.	Area of Land used for Filtration or Irrigation. 10.	Rate of Filtration in Gallons per Acre. 11.	Additional Area of Land owned but not used for Filtration. 12.	Sludge: How Disposed of. 13.	Number of Samples Above Limit.	Number of Samples Below Limit.	Total Samples.	Percentage of Samples Below Limit.	REMARKS.
2ft. polarite	Intermittent	None	1,364,880	3 acres, including area occupied by works.	None disposed of yet	–	5	5	100	—
2ft. 9in. polarite	Intermittent	None	1,272,920	7 acres, including area occupied by works.	Given to farmers	–	7	7	100	—
2ft. 7in., in following material:—7in. sand, 12in. sand and polarite mixed, 2in. sand, 2in. pea gravel, 2in. bean gravel, and 6in. broken stone.	Intermittent	Land only used for storm water and the washing from filter beds.	2,218,333	—	By running in sludge lagoons and allowing it to dry to enable it to be removed on to land.	2	7	9	78	–
1ft. 9in. gravel and sand	Intermittent	Nil	3,005,640	Nil	Removed by farmers	–	7	7	100	—
Rough clinkers, 1ft. 6in.; fine cinders, 6in.; charcoal, 3in.; river gravel, 7in.; total depth, 2ft. 11in.	Intermittent	—	5,585,360	—	Dried on spoil bank, and removed under contract at 1*s.* per load.	8	6	14	43	-
3 ft. sand, polarite, and gravel.	Intermittent	None	2,332,880	5 acres	Partly to farmers and partly on own land.	—	8	8	100	
2 ft. 6 in., composed of broken stone and cinders or mill ashes.	Intermittent	None at present	4,506,040	About 4½ acres	Have at work two sludge presses. The sludge is sold to farmers.	—	8	8	100	—
Cinders 3 ft. 6 in. deep	—	None	82,280	—	Spread on the land	2	4	6	67	—
3 ft. 6 in. gravel and cinders.	Intermittent	—	629,200	4 acres	Disposed of on the land belonging to the Council.	3	12	15	80	—
3 ft. boulder coke, gravel, and ashes.	Intermittent	None	2,579,720	None	On land	6	3	9	33	Remainder of district mostly rural.
Polarite filters, 3 ft. deep, viz., 9 in. Lowestoft sand, 9 in. polarite and sand, 3 in. coarse Oporto sand, 15 in. gravel, in sizes graduated from pea gravel to size of walnut; 36 rows of 4 in drain tiles, 18 in. apart at bottom of filters.	Intermittent	Use 3,000 square yards for filtering sand washing water; 16,000 gallons per day.	2,720,080	The total area of land at sewage works is about 15¾ acres.	Given to farmers for use as manure.	1	7	8	88	Sewers now being constructed to connect up remainder of district.
Fine furnace ashes 1 ft. 9 in., and broken ballast, 1 ft. 9 in.; total, 3 ft. 6 in.	Intermittent	None	5,183,640	2⅓ acres	Taken by farmers	—	8	8	100	Works are now in course of construction for the remainder of the district.
15 in., comprising 12 in. magnetite and 3 in. sand.	Intermittent	80 acres. 3,750 gallons per acre.	2,904,000	53 acres	Dug into land	8	3	11	27	—
3 ft deep, ashes	Intermittent	—	2,637,800	500 square yards	Collected on sludge filter beds, and when solid wheeled on land.	1	5	6	83	—
5 feet deep, ashes	Intermittent	—	5.866,080	4½ acres	—	—	8	8	100	—
Sand and ashes	Intermittent	—	96,800	600 square yards	Removed by farmers at a cost of 10*l.* per annum.	1	5	6	83	—
Cinders 3 ft. deep	Continuous	484 square yards	832,480	3 acres			5	5	100	—

MERSEY AND IRWELL WATERSHED—*continued.*

PARTICULARS as to the methods of Sewage Treatment adopted by the Local Authorities in the Mersey and

NAME OF AUTHORITY.	Population.	Population Connected up. 1.	Estimated Quantity of Sewage in 24 hours. 2.	Character of Trade Waste in Sewage. 3.	Number of Precipitation Tanks and Total Capacity. 4.	Precipitant used. 5.	Quantity of Precipitant used per week. 6.	Number of Filters and Total Area. 7.
PRECIPITATION AND ARTIFICIAL FILTRATION—*continued.*								
(D) CHEMICAL PRECIPITATION AND RAPID (MECHANICAL ?) FILTRATION.								
SEWAGE MIXED WITH TRADE WASTE.								
Hyde Corporation - - - - - -	30,670	About 30,000	About 1,250,000 gallons.	1 dye works, hat works, 1 leather dresser.	6 tanks. Total capacity 450,000 gallons.	Lime and proto-chloride of iron during the day; alumina ferric at night.	Day, 22 grains per gallon; night, 7 grains per gallon.	12 filters. Total area 1,476 square yards; 846 gallons per square yard.
Mossley Corporation - - - - -	15,000	14,000 to 15,000	250,000 gallons, dry weather flow.	1 wool scourer, 1 dye works.	6 tanks. Total capacity 376,630 gallons.	Alumina ferric usually, but sometimes ferrozone.	26 cwt. - - -	11 filters. Total area 838 square yards; 298 gallons per square yard.
Astley Bridge Urban District Council - -	6,200	5,900	Dry weather flow, 120,000 gallons per day.	1 dye works -	3 tanks. Total capacity 180,000 gallons.	Lime and copperas and alumina ferric.	About 1,450 lbs. of lime per week; 1,450 lbs. of copperas per week.	3 filters. Total area 364 square yards; 329 gallons per square yard.
Droylsden Urban District Council - -	10,500	10,500	550,000 gallons	Dye works, print works, bleach works, chemical works.	6 tanks. Total capacity 1,054,080 gallons.	Alumina ferric -	30 cwt. - - -	9 filters. Total area 864 square yards; 636 gallons per square yard.
Gorton Urban District Council - -	25,000	Between 20,000 and 25,000	500,000 gallons, dry weather flow.	Chemical works -	2 detritus and 3 precipitation tanks. Total capacity 1,215,000 gallons.	Alumina ferric -	10 cwt. per 1,000,000 gallons.	6 filters. Total area 2,700 square yards; 185 gallons per square yard.
Radcliffe Urban District Council - -	26,000	22,850	1,100,000 gallons	7 dye works; 3 breweries; 1 bleach works.	4 tanks. Total capacity 528,000 gallons.	Alumina ferric -	1½ to 2 tons of alumina ferric.	4 filters. Total area 1,000 sq. yds.; 1,100 gallons per square yard.
Reddish Urban District Council - -	7,500	About 7,500	Probably 150,000 gallons per day (dry weather), a considerable quantity (probably one-half) being manufacturing refuse.	Carbolic acid manufacture.	2 tanks. Total capacity 76,208 gallons.	Alumina ferric -	About 25 cwt. -	4 filters. Total area 320 sq. yds.; 468 gallons per square yard.
Stockport Rural District Council (Offerton) (portion of).	—	About 4,500	125,000 gallons	1 print works -	3 tanks. Total capacity 150,000 gallons.	Alumina ferric -	About 12 cwt. to 15 cwt.	2 filters. Total area 320 sq. yds.; 390 gallons per square yard.
(E) CHEMICAL PRECIPITATION AND BIOLOGICAL FILTRATION.								
DOMESTIC SEWAGE ONLY.								
None - - - - - - - - -	—	—	—	—	—	—	—	—
(F) CHEMICAL PRECIPITATION AND BIOLOGICAL FILTRATION.								
SEWAGE MIXED WITH TRADE WASTE.								
Oldham Corporation - - - - -	131,463	Not yet ascertained.	3,250,000 gallons	1 dye works; 1 brewery.	12 tanks. Total capacity 2,073,600 gallons.	Copperas and lime water.	Automatic, according to the quantity of sewage coming down. Copperas, about 1 grain per gallon, and lime about 3·7 grains per gallon.	9 filters. Total area 12,600 sq. yds.; 257 gallons per square yard.
Swinton and Pendlebury Urban District Council (Swinton) - - - - -	26,000	About 18,000	640,000 gallons dry weather flow	Print works -	4 tanks. Total capacity 216,450 gallons.	Lime and copperas	7 grains of lime and 7 grains of copperas to the gallon.	Land and cinder filters, 1 acre, 2,910 sq. yds.; coke filter, 350 sq. yds.; cinder filters, 2,420 sq. yds. Total area 10,520 sq. yds.; 61 gallons per square yard.
Swinton and Pendlebury Urban District Council (Pendlebury).		About 7,000	About 160,000 gallons dry weather flow	1 dye works -	3 tanks. Total capacity 413,550 gallons.	Alumina ferric -	About 13 cwt.	Polarite, 150 sq. yds. Land and cinder filters, 3,244 sq. yds. Total area 3,494 sq. yds.; 45 gallons per square yard.

MERSEY AND IRWELL WATERSHED—*continued.*

Irwell Watershed, derived from information supplied by the Authorities to the Joint Committee—*continued.*

Depth and Character of Filtering Material. 8.	Method of using Filters (whether Intermittent or Continuous). 9.	Area of Land used for Filtration or Irrigation. 10.	Rate of Filtration in Gallons per Acre. 11.	Additional Area of Land owned but not used for Filtration. 12.	Sludge: How Disposed of. 13.	Number of Samples Above Limit.	Number of Samples Below Limit.	Total Samples.	Percentage of Samples Below Limit.	Remarks.
Total depth 4 ft. 3 in., viz., top layer sand, 10 in.; pebbles, 1 in.; polarite and sand, 1 ft. 2 in.; chatter, 6 in.; rubble, 1 ft. 8 in.	Not working -	None used - - -	4,094,640	About 10 acres -	By pressing, and afterwards taken by farmers.	9	—	9	—	Under an order of Court to construct further works.
Total depth about 2 ft. 4 in. Top layer, Leighton Buzzard sand; next layer polarite and sand mixed; below, sand and gravel.	Each filter works 8 hours and rest 16 hours per 24 hours.	None at present -	1,442,320	About 8 to 10 acres	Pressed, and readily disposed of to farmers.	1	4	5	80	—
(1) 5ft. to 6 ft. cinders, sand, and gravel; (2) 3ft. sand, polarite, and gravel; (3) 1 ft. 6 in., sand and gravel.	Intermittent -	None - - - -	1,592,360	—	Carted away and used as manure on grass land belonging to the Council.	3	5	8	63	—
3 ft. 6 in., rough and fine gravel, polarite, and sand.	Intermittent -	None - - - -	3,078,240	4 acres - - -	Deposited in tanks or lagoons and allowed to dry.	1	6	7	86	—
6 in. sand, 12 inch sand and polarite mixed, 3 in. sand, 3 in. pea gravel, 3 in. bean gravel, 12 in. broken stone.	Continuous -	None at present -	895,400	Have a farm situate 40 ft. above outfall works; the area is about 20 acres.	By sludge-pressing machine.	2	6	8	75	Works designed to deal with 1 in. rainfall in addition to ordinary flow.
250 sq. yds, containing 9 in. of polarite and 2 ft. 4 in. of gravel and sand; 750 sq. yds., containing 9 in. of cinders and 2 ft. 4 in. of gravel and sand.	Intermittent -	None - - - -	5,324,000	5 acres to be used for land treatment after the works in course of construction are completed.	Pumped into lagoons and air-dried at present.	6	6	12	50	The whole of the nominal flow is passed through the tanks, but only a portion is filtered; additional works are being constructed.
About 2 ft. 4 in. top layer of Leighton Buzzard sand, next layer polarite and sand mixed.	Intermittent, with self-acting syphons.	None - - - -	2,265,120	Total area of land owned, 8½ acres; 5 acres available by gravitation.	Partially drained and dried in open lagoons and then allowed to dry upon a plot of land, and a small part of it then disposed of to farmers.	*7	0	7	0	*These samples are satisfactory as regards sewage impurity, although above the limit, as estimated by the oxygen test
2 ft. 6 in. gravel - -	Intermittent -	None - - - -	1,887,600	1½ acres - - -	Mixed with gas lime and carted away by local farmers.	3	10	13	77	—
—	—	—	—	—	—	—	—	—	—	—
Average depth 2 ft. 3 in., composed of carefully screened engine ashes, that no dust or dirt or rubbish of any kind can be put into the beds.	Intermittently. The beds are filled, allowed to stand full for a certain period, emptied, and then allowed to remain empty for some time before being filled again.	None - - - -	1,243,880	40 acres - - -	Farmers in the neighbourhood take it when it is pressed into cakes; also disposal of any not so taken on a small portion of land.	2	6	8	75	The filtration area is to be increased.
Coke 4 ft., cinders 3 ft. 6 in.	Intermittent -	10 acres, 50,000 gallons per acre.	295,240	27 acres - - -	Used for farming purposes.	5	8	13	62	—
Polarite 3 ft., land and cinders 3 ft. 6 in.	Intermittent -	3,494 sq. yds. - -	217,800	1 acre 35 perches -	Stored on land - -	1	8	9	89	—

MERSEY AND IRWELL WATERSHED—*continued.*

PARTICULARS as to the methods of Sewage Treatment adopted by the Local Authorities in the Mersey and

NAME OF AUTHORITY.	Population.	Population connected up. 1.	Estimated Quantity of Sewage in 24 hours. 2.	Character of Trade Waste in Sewage. 3.	Number of Precipitation Tanks and Total Capacity. 4.	Precipitant used. 5.	Quantity of Precipitant used per Week. 6.	Number of Filters and Total Area. 7.
PRECIPITATION AND LAND FILTRATION.								
(G) CHEMICAL PRECIPITATION AND LAND FILTRATION.								
DOMESTIC SEWAGE ONLY.								
Hindley Urban District Council	19,000	About 18,000	250 000 gallons	—	2 tanks. Total capacity, 500,000 gallons.	Alumina ferric	About 2 tons	—
Moss Side Urban District Council	27,000	27,000	810,000 gallons dry weather flow.	—	6 tanks. Total capacity, 652 660 gallons.	Alumina ferric	35 cwt.	None
West Houghton Urban District Council (Rogers' Farm) (portion of).		About 10 500	200,000 gallons	—	2 tanks. Total capacity, 450,000 gallons.	Copperas, manganese liquor, and lime.	Copperas, 10 cwt.; manganese liquor, 7 carboys; lime, about 1 ton 5 cwt.	2 filters. Total area, 1,000 sq. yds.; 200 gallons per square yard.
Wilmslow Urban District Council (Northern Works) (portion of).	—	2,500	—	—	2 tanks. Total capacity, 89,400 gallons.	Alumina ferric	1½ cwt.	—
Worsley Urban District Council (Boothstown) (portion of).	—	1,650	50,000 gallons	—	2 tanks. Total capacity, 26,000 gallons.	Lime and alumina ferric.	4½ cwt.	—
Chapel-en-le-Frith Rural District Council	14,129	2,200	50,000 gallons	—	3 tanks in each series, worked in duplicate, 100,000 gallons in each series. Total capacity, 200,000 gallons.	Alumina ferric	5 cwt	—
(H) CHEMICAL PRECIPITATION AND LAND FILTRATION.								
SEWAGE MIXED WITH TRADE REFUSE.								
Rochdale Corporation	71 400	Approximately 50,000	1,600,000 gallons dry weather flow at present.	3 woollen works; 1 brewery.	8 tanks for Roch outfall, capacity, 1,410,000 gallons, and 3 tanks for sudden outfall, capacity 300,000 gallons. Total capacity, 1,710,000 gallons.	Alumina ferric	5 tons	—
Castleton Urban District Council	5,700	5,300 estimated	185,000 gallons	Several tanneries	3 precipitation tanks. Total capacity, 112,500 gallons.	Alumina ferric	14 cwt. per week	5 filters. Total area, 480 sq. yds.; 385 gallons per square yard.
SUBSIDENCE AND LAND FILTRATION.								
(I) DOMESTIC SEWAGE ONLY:								
Alderley Edge Urban District Council	2,218	2,200	30 240 gallons (dry weather), 250,000 gallons (wet weather).	—	2 small tanks	—	—	—
Bury Rural District Council (Tottington) (portion of).	—	2,000	20,000 gallons	—	2 tanks. Total capacity 120,000 gallons.	None	—	—
(J) SEWAGE MIXED WITH TRADE REFUSE:								
Eccles Corporation	35 000	35,000	1,000,000 gallons, dry weather flow.	2 silk works, 2 dye works, 1 bleach works.	2 detritus tanks, 2 settling tanks. Total capacity 650,000 gallons.	None	None	
Bucklow Rural District Council (Timperley) (portion of).	—	2,015	—	1 tannery	3 tanks. Total capacity 64,781 gallons.	None	—	—

MERSEY AND IRWELL WATERSHED—*continued.*

rwell Watershed, derived from information supplied by the Authorities to the Joint Committee—*continued.*

Depth and Character of Filtering Material. 8.	Method of using Filters (whether Intermittent or Continuous). 9.	Area of Land used for Filtration or Irrigation. 10.	Rate of Filtration in Gallons per Acre. 11.	Additional Area of Land owned but not used for Filtration. 12.	Sludge: How Disposed of. 13.	Number of Samples Above Limit.	Number of Samples Below Limit.	Total Samples.	Percentage of Samples Below Limit.	REMARKS.
—	Intermittent -	About 5 acres - -	50,000	6 acres - - -	Carted away by farmers	—	7	7	100	—
—	—	27 acres, intermittent irrigation.	30,000	10½ acres - -	—	2	2	4	50	—
About 3 ft. deep. Material: Common engine ashes, screened, the coarse ashes being placed in the bottom layers and the fine in the top.	Intermittent -	About 50 acres available.	968,000	12 acres - - -	Carted on the land -	3	5	8	63	The filters have been constructed recently in consequence of the land being unsuitable for filtration.
—	—	5 acres - - -	10,000	4 acres - -	—	1	7	8	88	Rate of filtration calculated on basis of 20 gallons per head per day.
—	—	4 acres - - -	12,500	10 acres - - -	Removed by farmers -	—	6	6	100	—
—	—	4 acres - - -	12,500	4 acres, of which 2 are available for future use.	—	—	4	4	100	—
—	—	60 acres - - -	26,666	31 acres - - -	Pressed, and cake taken by farmers.	10	9	19	47	—
4 filters composed of coke 3 ft. deep, from 2½ in. to ¼ in. and less, sand, 9 in. Low level filter, composed of gravel 7 in., magnetite 12½ in., sand 4½ in.	Intermittent -	2 acres, 92,500 gallons per acre.	1,863,400	Additional 5 acres, but not laid out.	Air-dried by means of sludge filter beds; but about to apply for a loan to erect sludge-pressing plant.	3	3	6	50	Additional area of and only lately sanctioned.
	—	3 acres - - -	10,080 dry weather flow.	None - - -	Sold by contract to neighbouring farmers for a small sum.	—	11	11	100	—
	—	2 acres - - -	10,000	4 acres - - -	Deposited on remaining 4 acres of land. Total amount of land for filtration or irrigation, 6 acres, but at present only 2 acres are used.	2	6	8	75	—
—	—	71 acres - - -	14,035	—	Disposed of on the land	—	9	9	100	—
—	—	2½ acres - - -	24,108	—	Dried and given to an adjoining farmer.	3	11	14	79	Rate of filtration calculated on basis of 30 gallons per head per day

MERSEY AND IRWELL WATERSHED—*continued.*

PARTICULARS as to the methods of Sewage Treatment adopted by the Local Authorities in the Mersey and

NAME OF AUTHORITY.	Population.	Population connected up.	Estimated Quantity of Sewage in 24 hours.	Character of Trade Waste in Sewage.	Number of Precipitation Tanks and Total Capacity.	Precipitant used.	Quantity of Precipitant used per Week.	Number of Filters and Total Area.
	*	1.	2.	3.	4.	5.	6.	7.
BROAD IRRIGATION.								
(K) DOMESTIC SEWAGE ONLY:								
Altrincham Urban District Council - -	12,700	About 16,000. Includes some outside population.	380,000 gallons, dry weather flow.	—	Small tank to intercept grosser solids.	None - - -	—	—
Ashton-on-Mersey Urban District Council	5,000	About 4,560	About 150,000 gallons.	—	1 tank. Capacity 5,000 gallons.	None - - -	—	—
Blackrod Urban District Council - -	750	750	7,500 gallons - -	—	None - - - -	—	—	—
Bowdon Urban District Council - -	2,800	About 2,500	138,250 gallons There is no doubt the figures given include much rain and spring water.	—	3 tanks. Total capacity 34,537 gallons.	None - - -	—	—
Irlam Urban District Council - - -	4,653	2,500	62,500 gallons	—	—	—	—	—
Lymm Urban District Council - - -	5,000	About 4,500	About 70,000 gallons.	—	1,000 lineal yards of deeply excavated carriers, with weirs giving upwards of 25,000 cubic feet capacity, in which the sewage is impounded.	—	—	—
Stretford Urban District Council - -	26,000	8,500	500,000 gallons	—	—	—	—	—
Westhoughton Urban District Council (Dog Holes) (portion of).	—	About 1,000	About 10,000 gallons.	—	—	—	—	—
Westhoughton Urban District Council (Marsh Brook) (portion of).	—	About 1,000	About 15,000 gallons.	—	—	—	—	—
Wilmslow Urban District Council (Southern Works (portion of).	—	3,000	—	—	—	—	—	—
Withington Urban District Council (includes Levenshulme).	42,790	42,790	About 2½ million gallons (half subsoil water).	—	—	—	—	—
Bucklow Rural District Council (Dunham Massey) (portion of).	—	450 Remainder flows through Altrincham U. D. C.	—	—	2 tanks. Total capacity 14,400 gallons.	None - - -	—	—
Bucklow Rural District Council (Hale) (portion of).	—	2,740	—	—	1 tank. Total capacity 5,625 gallons.	—	—	—
Bucklow Rural District Council (Northenden) (portion of).	—	1,000	15,000 gallons	—	2 screwing tanks. Total capacity 13,500 gallons.	None - - -	—	—
(L) SEWAGE MIXED WITH TRADE REFUSE:								
Leigh Urban District Council - - -	32,000	32,000	—	1 print works -	—	—	—	—
Worsley Urban District Council (Barton Old Hall) (portion of).	—	15,425 (including 5,325 from Little Hulton U. D. C. District).	300,000 gallons and 160,000 gallons from Little Houlton district. Total 460,000 gallons.	Dye and bleach works.	None - - - -	—	—	—
Barton Rural District Council (Urmston and Flixton) (portion of).	—	13,000	260,000 gallons	Dye works - -	Small detritus tank -	—	—	—

MERSEY AND IRWELL WATERSHED—*continued.*

rwell Watershed, derived from information supplied by the Authorities to the Joint Committee—*continued.*

Depth and Character of Filtering Material. 8.	Method of using Filters (whether Intermittent or Continuous). 9.	Area of Land used for Filtration or Irrigation. 10.	Rate of Filtration in Gallons per Acre. 11.	Additional Area of Land owned but not used for Filtration. 12.	Sludge: How Disposed of. 13.	Number of Samples Above Limit.	Number of Samples Below Limit.	Total Samples.	Percentage of Samples Below Limit.	Remarks.
—	—	47 acres - - -	8,085	—	Used upon land not irrigated.	7	7	14	50	Are acquiring further area of 75½ acres.
—	—	About 8½ acres - -	17,647	½ acre - - -	Dried on land and given away to farmers.	—	7	7	100	—
—	—	17¾ acres - - -	422	—	On land - - -	—	4	4	100	—
—	—	About 7 acres set out in beds and planted with willows.	19,750	Land leased, 2 acres	The farmer who empties the tanks uses it.	1	10	11	91	The settling tanks merely intercept the grosser solids.
—	—	5 acres in use planted with willows, under-drained, 5 to 6 feet deep.	12,500	10 acres, the surface of which is 16 feet above the invert of sewer.	Sludge is put on the land.	—	5	5	100	—
—	—	15 acres planted with willows.	4,666	—	Periodically cleaned out of carriers and used as top dressing.	—	—	—	—	—
—	—	57 acres - - -	8,772	20 acres - - -	Pumped on to the land from receiving tank.	—		7	100	The remainder of the township is connected to the Manchester system.
—	—	15 acres - - -	666	7 acres - - -	Whole of sewage irrigated on land.	—	4	4	100	—
—	—	10 acres - - -	1,500	4 acres - - -	Whole of sewage irrigated on the land.	1	3	4	75	—
—	—	5 acres - - -	12,000	5 acres - - -	—	—	12	12	100	Rate of filtration calculated on basis of 20 gallons per head per day.
—	—	49 acres - - -	51,020	2 acres - - -	Used as manure upon land.	4	4	8	50	A scheme is in hand for additional works.
—	—	3½ acres - - -	3,857	—	Dried on land, and given to farmers of same farm.	1	6	7	86	Rate of filtration calculated on basis of 30 gallons per head per day.
—	—	13 acres - - -	6,323	—	Dried on land, and mixed with horse manure for cropping spare land.	3	14	17	82	Rate of filtration calculated on basis of 30 gallons per head per day.
—	—	4½ acres - - -	3,333	—	Dried and carted off -	3	7	10	70	—
—	—	140 acres - - -	4,000	80 acres - - -	—	3	2	5	40	Rate of filtration calculated on basis of 20 gallons per head per day. These works have lately been entirely remodelled, precipitation tanks, &c., built, and the sewage of Atherton has been brought to them.
—	-	42 acres - - -	10,952	86 acres - - -	Used by farmers on land adjoining.	6	3	9	33	—
—	—	17 acres - - -	15,294	—	Removed by farmers -	2	3	5	60	Additional land being set out.

Appendix 3.

MERSEY AND IRWELL WATERSHED—*continued.*

SUMMARY OF RESULTS OF DIFFERENT METHODS OF TREATMENT.

Number of Works.	———	Number of Samples Above Limit.	Number of Samples Below Limit.	Total Samples.	Percentage of Samples Below Limit.
	CHEMICAL PRECIPITATION ALONE.				
1	(A) Domestic Sewage only - - -	—	6	6	100
7	(B) Sewage Mixed with Trade Waste -	83	9	92	10
	PRECIPITATION AND ARTIFICIAL FILTRATION.				
	(C) Chemical Precipitation and Rapid (Mechanical?) Filtration.				
21	Domestic Sewage only - - -	37	128	165	78
	(D) Chemical Precipitation and Rapid (Mechanical?) Filtration.				
8	Sewage Mixed with Trade Waste -	32	37	69	54
	(E) Chemical Precipitation and Biological Filtration.				
—	Domestic Sewage only - - -	None	None	None	None
	(F) Chemical Precipitation and Biological Filtration.				
3	Sewage Mixed with Trade Waste -	8	22	30	73
	PRECIPITATION AND LAND FILTRATION.				
	(G) Chemical Precipitation and Land Filtration.				
6	Domestic Sewage only - - -	6	31	37	84
	(H) Chemical Precipitation and Land Filtration.				
2	Sewage Mixed with Trade Refuse -	13	12	25	48
	SUBSIDENCE AND LAND FILTRATION.				
2	(I) Domestic Sewage only - - -	2	17	19	89
2	(J) Sewage Mixed with Trade Refuse -	3	20	23	87
	BROAD IRRIGATION.				
14	(K) Domestic Sewage only - - -	20	90	110	82
3	(L) Sewage Mixed with Trade Refuse -	11	8	19	42

R. A. TATTON, M. Inst. C.E.

Appendix 4.

APPENDIX No. IV.

PARTICULARS as to the METHODS OF SEWAGE TREATMENT adopted by the LOCAL AUTHORITIES in the WEST RIDING OF YORKSHIRE.

Sewage Disposal Works in the West Riding of Yorkshire. (Particulars furnished by the Sanitary Authorities except where otherwise stated.)

West Riding Rivers Board, H. MACLEAN WILSON, Chief Inspector.

SETTLEMENT OR CHEMICAL PRECIPITATION FOLLOWED BY ARTIFICIAL FILTRATION AND FILTRATION THROUGH LAND.

BARNOLDSWICK URBAN DISTRICT.—BARNOLDSWICK SEWAGE WORKS.

Date completed and brought into operation	March, 1897.		
Engineer	Messrs. Brierley & Holt, Blackburn.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	About 2,500 houses.		
Average daily flow of sewage in dry weather	About 45,000.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Wholly domestic. No.		
Number of water closets in area drained	30 W.C. 800 tippers.		
LAND.			
Total area	5 acres.		
Whether underdrained, and how?	Yes. Agricultural drain pipes.		
Nett area upon which sewage can be treated	4½ acres.		
TANKS.			
Number and total capacity	3. 35,620 gallons each = Total 106,860.		
Used all together, or in series	In series.		
Whether flow of sewage continuous, or time allowed for settlement	Settlement allowed.		
CHEMICALS.			
Nature	Ferozone (International Company's system).		
Quantity	From 8 to 10 grains per gallon.		
How added	By patent mixer.		
FILTERS.			
Number and total area	3. About 18 × 30 feet each.		
Construction	Rough gravel sand Polarite sand.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. No.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	3.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Adjustable valves.		
Proportion of flow in sewer to average flow when storm overflows begin to act	About double volume.		
COST OF—			
Land	I have no figures.		
Laying out of land	Do.		
Tanks	Do.		
Filters	Do.		
	1895.	1896.	1897.
SLUDGE.			
Amount	No returns made.		
How dealt with	Do.		
Cost, or	Do.		
Return	Do.		
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			
Reports of Inspectors { Satisfactory ... 4; Unsatisfactory 15 }		Analyses { Above limit... 1; Below limit... 1 }	

Appendix 4.

FEATHERSTONE URBAN DISTRICT.—SOUTH FEATHERSTONE SEWAGE WORKS.

Date completed and brought into operation	
Engineer	Mr. Geo. Hodson, M.I.C.E., Westminster.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Present time 1,395 houses. Area about 1,400 acres.
Average daily flow of sewage in dry weather	75,000 gallons per 24 hours.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, with a little trade.
Number of water closets in area drained	About 30.
LAND.	
Total area	29 acres.
Whether underdrained, and how?	Yes. At 6 feet deep, 5 yards apart, 3-inch tiles.
Nett area upon which sewage can be treated	About 12 acres.
TANKS.	
Number and total capacity	2 tanks, 100 × 50 × 2 feet 3 inches. 3 tanks, 60 × 30 × 3 feet, one of which now converted into Dibdin filter.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	
How added	In blocks in sewage flow.
FILTERS	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Three on sewers, 1 at outfall.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	2 act when sewer $\frac{2}{3}$ full, one when sewer is gorged and under pressure.
COST OF—	
Land	Have not these particulars.
Laying out of land	Do.
Tanks	Do.
Filters	Do.

	1895.	1896.	1897.
SLUDGE.			
Amount	No particulars kept.	Sludge dug into land as made.	
How dealt with	Do.		
Cost, or	Do.		
Return	Do.		
PRODUCE.			
Crops	Mangle Wurtzel.	Turnip, Swede.	Rye Grass, Oats.
Value	Crops are worth about £100 per annum.		
WORKING EXPENSES.			
Labour	Cannot allocate these particulars.		
Chemicals	Do.		
Pumping	Do.		

Reports of Inspectors { Satisfactory ... 8; Unsatisfactory 15 }

Analyses { Above limit ... 1; Below limit ... 1 }

Appendix.

FEATHERSTONE URBAN DISTRICT.—SNYDALE SEWAGE WORKS.

Date completed and brought into operation	October, 1898.
Engineer	Messrs. G. & F. W. Hodson, Westminster. W. A. Palliser, [Resident Engineer for the works.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	About 2,500 acres. Population, estimated, 4,000.
Average daily flow of sewage in dry weather	Not gauged, but about 70,000 gallons for 24 hours.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes, to some extent.
Number of water closets in area drained	About 20.
LAND.	
Total area	7 acres.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	6 acres.
TANKS.	
Number and total capacity	One inverted cone tank. 60,000 gallons.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	Not yet decided.
How added	In blocks in sewage flow.
FILTERS.	
Number and total area	Seven. One of about 200 square yards, 6 of total area 300 square yards.
Construction	9 inches clinker, 26 inches coke, 6 inches coal or broken stone.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	One continuously for 6 days, 1 day's aëration; six intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two on sewer, one at outfall.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	When sewer running ¾ full.
COST OF—	
Land	Total cost £8,500.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	Not yet ascertained.		
How dealt with	Do.		
Cost, or	Do.		
Return	Do.		
PRODUCE.			
Crops	Do.		
Value	Do.		
WORKING EXPENSES.			
Labour	Do.		
Chemicals	Do.		
Pumping	Do		

Reports of Inspectors {Satisfactory ... 9; Unsatisfactory 3}

Analyses {Above limit ... ; Below limit ... -}

Appendix 4.

NORMANTON URBAN DISTRICT.—NORMANTON SEWAGE WORKS.

Date completed and brought into operation	1887.
Engineer	Messrs. Brundell & Simmons, Doncaster.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1,228 acres. 12,570 estimated population.
Average daily flow of sewage in dry weather	100,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	(1) Domestic. (2) Yes.
Number of water closets in area drained	49.
LAND.	
Total area	$4\frac{1}{2}$ acres.
Whether underdrained, and how?	4×6 inch field pipes, branches 12 feet apart.
Nett area upon which sewage can be treated	$2\frac{1}{2}$ acres.
TANKS.	
Number and total capacity	Three. 75,000 gallons.
Used all together, or in series	Used all together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	14 cwts. per week.
How added	In slabs as delivered.
FILTERS.	
Number and total area	Three.
Construction	12 inches of gravel, 12 inches of polarite and sand, and 15 inches of sand.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. No.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	Say normal flow $\frac{1}{6}$ when overflow acts $\frac{5}{6}$
COST OF—	
Land	£1,083 11*s.* 0*d.*
Laying out of land	£338 8*s.* 0*d.*
Tanks	£345 18*s.* 2*d.*
Filters	£317 1*s.* 8*d.* Engine house and machinery £528 11*s.* 11*d.*

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Given to farmers.	Given to farmers.	Given to farmers.
Cost, or			
Return			
PRODUCE.			
Crops	Grass.	Grass.	Grass.
Value			12*s.* 6*d.*
WORKING EXPENSES.			
Labour	£106 17*s.* 2*d.*	£94 1*s.* 10*d.*	£178 12*s.* 10*d.*
Chemicals	£114 8*s.* 10*d.*	£123 7*s.* 6*d.*	£142 10*s.* 5*d.*
Pumping	£143 12*s.* 0*d.*	£98 7*s.* 2*d.*	£104 11*s.* 6*d.*

Reports of Inspectors { Satisfactory ... 17; Unsatisfactory 2

Analyses { Above limit ... –; Below limit ...

Appendix 4.

RAWMARSH URBAN DISTRICT.—RAWMARSH SEWAGE WORKS.

Date completed and brought into operation	17th December, 1896.
Engineer	Mr. J. Platts, Rotherham.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1,581 acres. 2,668 houses. 13,340 population.
Average daily flow of sewage in dry weather	250,000.
Nature of sewage (domestic or mixed with trade refuse.) Is surface water included?	Both. Partly.
Number of water closets in area drained	327.
LAND.	
Total area	Eleven acres.
Whether underdrained, and how?	3-inch agricultural pipes, 25 feet 0 inch apart, average depth 1 foot 10 inches, and conducted into 9-inch main carrier and open dyke to the River Don.
Nett area upon which sewage can be treated	8 acres.
TANKS.	
Number and total capacity	3 nests of 100,776 gallons each.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Not continuous. 4 to 8 hours allowed for settlement.
CHEMICALS.	
Nature	Ferozone.
Quantity	16 grains per gallon.
How added	By Kierby's mixing apparatus.
FILTERS.	
Number and total area	4=1,170 square feet.
Construction	Polarite.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method?	Intermittently. No.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	4; none at outfall works.
Construction — whether fixed side weirs, leaping weirs, or adjustible valves	2 adjustable valves. 2 fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	The adjustable valves are never opened, and one side weir is fixed too high to act, and one at the pumping station does not come into operation until all the storage tanks are overflowing. Capacity 140,000 gallons.
COST OF—	
Land	£1,942 13*s*. 0*d*.
Laying out of land Tanks Filters	£6,865. We are unable to ascertain the cost of each separate, as the contract has not been certified for by the Engineer.

	1895.	1896.	1897.
SLUDGE.			
Amount			589 tons per ann., containing 50 per cent. moisture, or about 300 tons dry.
How dealt with			Given to farmers.
Cost, or			No special labour. Gas engine to pump. Gas account, £20 3*s*. 2*d*.
Return			Do.
PRODUCE.			
Crops			Rye grass sold for about £4, and 10 tons in stock.
Value			
WORKING EXPENSES.			
Labour			£248 2 4
Chemicals			£216 0 0
Pumping			£191 8*s*. 10d., which includes all expenses incurred (labour only £86 3*s*. 2*d*.)

Reports of Inspectors { Satisfactory ... 7; Unsatisfactory 23

Analyses { Above limit .. 1; Below limit 3

Appendix 4.

THORNTON URBAN DISTRICT.—THORNTON SEWAGE WORKS.

Date completed and brought into operation	September 25th, 1895.		
Engineer	John Drake, A.M.I.C.E., Queensbury, near Bradford.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	141 acres. 800 houses. 4,000 population.		
Average daily flow of sewage in dry weather	120,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic and surface water included.		
Number of water closets in area drained			
LAND.			
Total area	4 acres 29¾ perches.		
Whether underdrained, and how?	Underdrained. 4-inch land tiles.		
Nett area upon which sewage can be treated	About two acres.		
TANKS.			
Number and total capacity	Receiver 126,562 gallons, 6 precipitation tanks 225,000.		
Used all together, or in series	In series of three.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.		
CHEMICALS.			
Nature	Alumino-ferric.		
Quantity			
How added	In slabs washed in open channel.		
FILTERS.			
Number and total area	Two, each 60 feet × 20 feet = 133 yards each.		
Construction	Sand only.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Three.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Overleaping.		
Proportion of flow in sewer to average flow when storm overflows begin to act	4 volumes.		
COST OF—			
Land	£496 11*s.* 4*d.*		
Laying out of land, Tanks, Filters	£3,563·12*s.* 0*d.*		
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount			
How dealt with	As manure by farmers and others.		
Cost, or			
Return	None.		
PRODUCE.			
Crops	Allowed Caretaker as part salary.		
Value	Do.		
WORKING EXPENSES.			
Labour		£34 9 0	£39 0 0
Chemicals		£33 16 6	£17 9 2
Pumping	None.		

Reports of Inspectors { Satisfactory ... 15 / Unsatisfactory 5 }

Analyses { Above limit ... 3 / Below limit ... - }

Appendix 4.

DONCASTER RURAL DISTRICT.—CONISBROUGH SEWAGE WORKS.

Date completed and brought into operation	
Engineer	George White.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1856. Population 9,280.
Average daily flow of sewage in dry weather	855,000.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	About 20.
LAND.	
Total area	3 acres.
Whether underdrained, and how?	Underdrained. 4 inch pipes.
Nett area upon which sewage can be treated	$2\frac{1}{2}$ acres.
TANKS.	
Number and total capacity	Three. 66 feet × 27 feet × 6 feet, capacity 57,888 each.
Used all together, or in series	Alternative.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	International purification by means of the addition of polarite and ferozone.
Quantity	
How added	
FILTERS.	
Number and total area	Six. 2,364 square feet.
Construction	Broken stone, gravel, and polarite.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One near ferry and one near outfall site.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Adjustable.
Proportion of flow in sewer to average flow when storm overflows begin to act	One and $\frac{1}{2}$.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 13; Unsatisfactory 5

Analyses: Above limit ... –; Below limit .. 1

Appendix 4.

HEMSWORTH RURAL DISTRICT.—SHAFTON TWO GATES SEWAGE WORKS.

Date completed and brought into operation	1892.
Engineer	T. H. Richardson.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only.
Number of water closets in area drained	None.
LAND.	
Total area	½ acre.
Whether underdrained, and how?	Not underdrained.
Nett area upon which sewage can be treated	⅛ acre.
TANKS.	
Number and total capacity	Two tanks, 10 feet 0 inch × 10 feet 0 inch each 3 feet deep.
Used all together, or in series	Used in series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	2 filters, 16 feet 0 inch × 16 feet 0 inch each 4 feet deep.
Construction	Sand and polarite.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuous flow.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	And easements, £175 0s. 0*d*.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Not utilized.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			
WORKING EXPENSES.			
Labour	£3 6s. 0*d*. per quarter, including Shafton.		
Chemicals	None.		
Pumping	None.		

Reports of Inspectors { Satisfactory ... 14; Unsatisfactory }

Analyses { Above limit ...; Below limit ... }

HUNSLET RURAL DISTRICT.—HALTON (PORTION OF TEMPLE NEWSAM) SEWAGE WORKS

Date completed and brought into operation	January, 1898.		
Engineer	Sam Shaw, Dewsbury.		
Whether sanctioned by L.G.B.			
Area and population or number of houses drained	316 houses. Surface water into storm water sewers.		
Average daily flow of sewage in dry weather	About 12,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Part surface and part roof water of a small part.		
Number of water closets in area drained	Eighteen.		
LAND.			
Total area			
Whether underdrained, and how?			
Nett area upon which sewage can be treated			
TANKS.			
Number and total capacity	Two. 20,000 gallons.		
Used all together, or in series	Together or separately.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	Alumino-ferric.		
Quantity	41 cwts. in six months.		
How added	Slabs on end or edge at point of discharge from sewer.		
FILTERS.			
Number and total area	Four. 1,740 feet super.		
Construction	Drain tiles on bottom, general mixture—gravel, coke breeze, and burnt shale.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. No.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	One at outfall.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Small weir adjustable.		
Proportion of flow in sewer to average flow when storm overflows begin to act	The whole could be let go.		
COST OF—			
Land			
Laying out of land			
Tanks	About £500		
Filters			
	1896.	**1897.**	**1898.**
SLUDGE.			
Amount			About 7 to 8 tons.
How dealt with	Run from tanks on to clinker bed faced with ashes to drain. When cartable to land.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			About £20 per year
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 10; Unsatisfactory 5

Analyses { Above limit ... –; Below limit ... –

Appendix 4.

ROTHERHAM RURAL DISTRICT.—CANKLOW (WHISTON) SEWAGE WORKS.

Date completed and brought into operation	1897.
Engineer	J. Platts.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	221 houses. Estimated population, 1,200.
Average daily flow of sewage in dry weather	24,360 gallons, estimated.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. No trade sewage. A little yard water. Roof water caught in tubs.
Number of water closets in area drained	Three.
LAND.	
Total area	2 acres.
Whether underdrained, and how?	Yes. Every 10 feet.
Nett area upon which sewage can be treated	1½ acres.
TANKS.	
Number and total capacity	Nest of 5 on Magnetite's system. 1,700 gallons each.
Used all together, or in series	Used continuously.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Magnetite's Co.'s ferral.
Quantity	6 cwt. per 1,000,000 gallons.
How added	Placed under pump outlet in bulk and mixed in mixing race.
FILTERS.	
Number and total area	2. 200 square feet each.
Construction	Brick walls, filtering, and magnetite sand medium.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Alternate 24 hours. Not Dibdin's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£400.
Laying out of land	£422
Tanks	£300
Filters	£300.

	1895.	1896.	1897.
SLUDGE.			
Amount			1½ tons per week, fairly dry.
How dealt with			Spread out on adjoining fields.
Cost, or			Nil.
Return			
PRODUCE.			
Crops			Not yet planted.
Value			
WORKING EXPENSES.			
Labour			10s. per week.
Chemicals			£26 per annum.
Pumping			£25 per annum, say £5 for oil, waste, and renewal.

Reports of Inspectors: Satisfactory ... 20; Unsatisfactory 1

Analyses: Above limit ... –; Below limit ... –

Appendix 4.

SADDLEWORTH RURAL DISTRICT—DELPH, DIGGLE, AND DOBCROSS SEWAGE WORKS.

Date completed and brought into operation	31st December, 1896.
Engineer	Mr. T. S. McCallum, Manchester.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 4,160.
Average daily flow of sewage in dry weather	41,600 gallons (estimated).
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. A portion of surface water conveyed to works.
Number of water closets in area drained	
LAND.	
Total area	$4\frac{1}{2}$ acres.
Whether underdrained, and how?	Partially.
Nett area upon which sewage can be treated	$1\frac{1}{4}$ acres.
TANKS.	
Number and total capacity	2 tanks, each 17 feet 6 inches diameter × 12 feet 0 inches deep. 36,079 gals.
Used all together, or in series	Sometimes together, sometimes singly, according to flow.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	About 9 cwt. per week.
How added	Basket in inlet channel.
FILTERS.	
Number and total area	3 beds, each 28 feet 9 inches × 15 feet 0 inches; 144 square yards.
Construction	About 2 feet 5 inches filtering material in centre, made up as follows:—Sand 7 inches, polarite 6 inches, mixed with 4 inches sand, pea gravel 2 inches, bean gravel 3 inches, walnut gravel 2 inches, boulders 5 inches.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	7 on sewers, 1 at works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weirs on sewers, automatic arrangements at works.
Proportion of flow in sewer to average flow when storm overflows begin to act	7 to 10 times.
COST OF.	
Land	£1,103.
Laying out of land	Not yet completed.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Run into lagoons, dried and usedas manure by farmers.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping	None.		

Reports of Inspectors { Satisfactory ... 28; Unsatisfactory 2 } ... Analyses { Above limit ... 2; Below limit .. }

Appendix 4

SWINTON URBAN DISTRICT.—SWINTON SEWAGE WORKS. (Alterations and Additions).

Date completed and brought into operation	20th December, 1898.
Engineer	R. Fowler, C.E.
Whether sanctioned by L.G.B.	Yes. Amount £2,000.
Area and population or number of houses drained	2,284 houses.
Average daily flow of sewage in dry weather	About 150,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included ?	Little trade refuse. Part.
Number of water closets in area drained	116.
LAND.	
Total area	6·647 acres.
Whether underdrained, and how ?	Yes.
Nett area upon which sewage can be treated	5 acres.
TANKS.	
Number and total capacity	Two. 42,587 gallons each = 85,174.
Used all together, or in series	Together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	8 to 10 grains per gallon.
How added	Slabs of alumino-ferric placed in channel dissolving in the sewage in proportion to the depth of immersion.
FILTERS.	
Number and total area	4 = 600 square yards.
Construction	Coke breeze.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Dibdin's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Five.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	When the rainfall increases the volume to be pumped exceeding the rate of 600 gallons per minute, all above that quantity discharges untreated.
COST OF—	
Land	£2,150.
Laying out of land	No record.
Tanks	£1,341 15*s.* 4*d.*
Filters	(included above)

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 2; Unsatisfactory 16 }

Analyses { Above limit –; Below limit – }

Appendix 4.

TONG URBAN DISTRICT.—DUDLEY HILL SEWAGE WORKS.

Date completed and brought into operation	Used first time November 21st, 1898, but not completed.
Engineer	John Drake, A.M.I.C.E., Queensbury.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	227 acres drained. 1,200 houses at 5 = 6,000.
Average daily flow of sewage in dry weather	Estimated 180,000 at 30 gallons per head.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed sewage. Yes.
Number of water closets in area drained	
LAND.	
Total area	4 acres 2 roods 12 perches enclosed for filtration areas.
Whether underdrained, and how?	Yes, by 4-inch land tiles, 11 yards apart in lines.
Nett area upon which sewage can be treated	14,085 superficial yards = 2 acres 3 roods 26 perches.
TANKS.	
Number and total capacity	Receiving dams, 126,562 gallons. 6 precipitating tanks 225,000 gallons.
Used all together, or in series	In series of 3.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	About 3 cwts. per day.
How added	In slab in open channel.
FILTERS.	
Number and total area	No. 2, each 360 yards superficial.
Construction	Sand and polarite.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Will be used continuously and alternately.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed leaping weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	7 Volumes.
COST OF—	
Land	Not yet paid for. Amount of loan sanctioned, £5,900. Amount of tender accepted £5,850. The works not measured off and certified.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.	Not been ascertained yet.		
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 7; Unsatisfactory 12

Analyses { Above limit ...; Below limit .. 1

Appendix 4.

WAKEFIELD RURAL DISTRICT.—CRIGGLESTONE SEWAGE WORKS.

Date completed and brought into operation	Early in 1897.
Engineer	Frank Massie, Assoc. M.Inst. C.E., Wakefield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	520 acres. 810 population at present.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water excluded as far as possible.
Number of water closets in area drained	Not more than 6.
LAND.	
Total area	4 acres 3 roods 5 perches.
Whether underdrained, and how?	Yes, but only one intercepting subsoil drain.
Nett area upon which sewage can be treated	1¼ acres.
TANKS.	
Number and total capacity	One Candy upward flow tank 14 feet 6 inches in diameter.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	4 tons a year.
How added	Blocks placed in inlet channel.
FILTERS.	
Number and total area	Two. 54 square yards.
Construction	Polarite, gravel, and sand.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently, but not on Dibdin's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	No record.
COST OF—	
Land	Taken on lease at £5 per acre.
Laying out of land	No exact record.
Tanks	Do.
Filters	Do.

	1895.	1896.	1897.
SLUDGE.			
Amount			No record.
How dealt with			Dried in lagoons and carted away on to land.
Cost, or			
Return			
PRODUCE.			
Crops			None.
Value			
WORKING EXPENSES.			
Labour			£54.
Chemicals			£24.
Pumping			

Reports of Inspectors: Satisfactory ... 12; Unsatisfactory 3

Analyses: Above limit ... –; Below limit ... –

Appendix 4.

WETHERBY UNION DISTRICT.—THORPARCH INDUSTRIAL SCHOOL SEWAGE WORKS.

Date completed and brought into operation	Midsummer, 1898.
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	School for 100 girls and 12 servants and officers.
Average daily flow of sewage in dry weather	1,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. One or two overflows from soft-water cisterns.
Number of water closets in area drained	4. Laundry gives the most sewage.
LAND.	
Total area	14 acres.
Whether underdrained, and how?	The land drains communicate with the road ditches.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	One deep tank (covered), which was originally constructed for sump. This tank we used as a "septic tank," except we have a ventilating shaft 36 feet high.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	No.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	2, each 16 feet by 9 feet.
Construction	Brick and cement, broken stone at bottom and coarse coke breeze, with fine topping.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Used alternately, changed daily. Practically Dibdin's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None, practically.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	Was built 30 years ago. No knowledge of its cost.
Filters	2. Were constructed at a cost of about £250, which included the cutting of trenches and laying drains.

	1895.	1896.	1897.
SLUDGE.			
Amount	None.		
How dealt with	Do.		
Cost, or	Do.		
Return	Do.		
PRODUCE.			
Crops	None.		
Value	Do.		
WORKING EXPENSES.			
Labour	None.		
Chemicals	Do.		
Pumping	Do.		

Reports of Inspectors { Satisfactory ... 2; Unsatisfactory - }

Analyses { Above limit ... -; Below limit ... - }

Appendix 4.

ARTIFICIAL FILTRATION.

GREASBORO' URBAN DISTRICT.—MANGHAM ROAD SEWAGE WORKS.

Date completed and brought into operation	1886 (Information not supplied by Authority.)
Engineer	Brundell & Simmons.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	1 septic and 1 detritus.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	3 filters.
Construction	Coke breeze.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Dibdin's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... –; Unsatisfactory 23

Analyses: Above limit ... –; Below limit ... –

Appendix 4.

GREASBORO' URBAN DISTRICT.—STONE ROW SEWAGE WORKS.

Date completed and brought into operation	1886. (Information not supplied by Authority.)
Engineer	Brundell & Simmons.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	30 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	1 grit chamber.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	3 filters.
Construction	Sand and polarite and pebbles.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory... – ; Unsatisfactory 20

Analyses: Above limit ... ; Below limit ... -

Appendix 4.

HORSFORTH URBAN DISTRICT.—HORSFORTH SEWAGE WORKS.

Date completed and brought into operation	28th July 1898.
Engineer	William Spinks, Esq., A.M.I.C.E., Leeds.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	No. of houses drained about 1,720.
Average daily flow of sewage in dry weather	113,000 gallons (estimated at).
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Chiefly domestic. Surface water is included to some extent. It is kept out where possible.
Number of water closets in area drained	About 92.
LAND.	
Total area	About 6¼ acres.
Whether underdrained, and how?	Nothing is done to it as yet.
Nett area upon which sewage can be treated	About 4½ acres, exclusive of filters.
TANKS.	
Number and total capacity	There are no tanks.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	No chemicals are used.
Quantity	
How added	
FILTERS.	
Number and total area	Eight filters. Total area about 256 square yard.
Construction	Excavated in clay.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently on Dibdin's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None, except at outfall. The present filters treat about 20,000 gallons per day, the rest of the sewage flowing into Cow Beck. Plans are being prepared by Mr. Spinks to treat the whole of the sewage on Dibdin's method. There is, at present, no properly constructed storm overflow.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£1,595.
Laying out of land	
Tanks	
Filters	£297 was the amount of contract.

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 8; Unsatisfactory 7

Analyses: Above limit ...; Below limit ...

Appendix 4.

MONK BRETTON URBAN DISTRICT.—FOUR LANE ENDS SEWAGE WORKS.

Date completed and brought into operation	1 878.	(Information not supplied by Authority.)
Engineer		
Whether sanctioned by L.G.B.		
Area and population or number of houses drained	200 houses.	
Average daily flow of sewage in dry weather		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.	
Number of water closets in area drained		
LAND.		
Total area		
Whether underdrained, and how?		
Nett area upon which sewage can be treated		
TANKS.		
Number and total capacity	Filter tank.	
Used all together, or in series		
Whether flow of sewage continuous, or time allowed for settlement		
CHEMICALS.		
Nature		
Quantity		
How added		
FILTERS.		
Number and total area		
Construction		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method		
STORM OVERFLOWS.		
Number on line of sewers and at outfall works		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves		
Proportion of flow in sewer to average flow when storm overflows begin to act		
COST OF—		
Land		
Laying out of land		
Tanks		
Filters		

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 10; Unsatisfactory 8

Analyses: Above limit -; Below limit -

Appendix 4.

MONK BRETTON URBAN DISTRICT.—OLD MILL SEWAGE WORKS.

Date completed and brought into operation	1879 (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	40 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Do tic.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	Filters (covered).
Construction	Coke.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... ; Unsatisfactory 18

Analyses: Above limit ; Below limit —

Appendix 4

SOUTHOWRAM URBAN DISTRICT.—HAIGH FIELD (SOUTHOWRAM) SEWAGE WORKS.

Date completed and brought into operation	October, 1895.
Engineer	W. H. D. Horsfall.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	No. of houses drained 75. Average population 5 per house, 375
Average daily flow of sewage in dry weather	Varies a good deal.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic (only). No surface water.
Number of water closets in area drained	None.
LAND.	
Total area	Four acres.
Whether underdrained, and how?	The land has all been quarried and filled in.
Nett area upon which sewage can be treated	Three acres.
TANKS.	
Number and total capacity	No., 3 tanks. 14 feet x 10 feet x 3 feet 6 inches, total capacity 10,695 gallons.
Used all together, or in series	Used all together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Two tanks answer as filters
Construction	Stone walls and concrete.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Used continuously.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	None.
Proportion of flow in sewer to average flow when storm overflows begin to act	None.
COST OF—	
Land	£8 a year. 30 years' lease from 2nd February, 1893.
Laying out of land	
Tanks	About £150.
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	Very small.		
How dealt with	Cleaned out by the Council's own men in course of their ordinary duties.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	No sum specifically appropriated to this. The scheme is a small one, and the working road surveyor attends to it in the course of his duties.		
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 11; Unsatisfactory – }

Analyses { Above limit ...; Below limit ... }

Appendix 4.

SOUTH CROSLAND URBAN DISTRICT.—ARMITAGE BRIDGE SEWAGE WORKS.

Date completed and brought into operation	1876. (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	339 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	
LAND.	
Total area	None.
Whether underdrained, and how?	Do.
Nett area upon which sewage can be treated	Do.
TANKS.	
Number and total capacity	Do.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	10 filter tanks.
Construction	Coke breeze.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors {Satisfactory ... / Unsatisfactory

Analyses {Above limit ... / Below limit ...

DONCASTER RURAL DISTRICT.—AUSTERFIELD SEWAGE WORKS.

Date completed and brought into operation	1876.
Engineer	Alfred Wright.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	241.
Average daily flow of sewage in dry weather	705.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included ?	Yes.
Number of water closets in area drained	None.
LAND.	
Total area	None.
Whether underdrained, and how ?	None.
Nett area upon which sewage can be treated	None.
TANKS.	
Number and total capacity	One. 25 × 12 × 6 divided into 3 chambers by iron plates.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	None.
Quantity	
How added	
FILTERS.	
Number and total area	None.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	Not known, very small.		
How dealt with	Disposed on land by contractor who empties tanks.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 4. Unsatisfactory –

Analyses: Above limit ... – Below limit ...

Appendix.

DONCASTER RURAL DISTRICT.—THURNSCOE SEWAGE WORKS.

Date completed and brought into operation	May, 1898.
Engineer	W. Spinks.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	367. Population 1835.
Average daily flow of sewage in dry weather	27,000 to 30,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	Three.
LAND.	
Total area	3½ acres.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	2½ acres.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	3 coarse bed 15 feet × 19 feet, and 5 fine bed 67 feet × 45 feet: 2 fine beds 35 feet × 24 feet.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Dibdin's.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	2 on line of sewer, 2 near outfall site, and 1 near vicarage.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	1½.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	1 man 30s. per week.		
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 4; Unsatisfactory 9

Analyses { Above limit ... 5; Below limit ... –

Appendix 4.

HALIFAX RURAL DISTRICT—NORWOOD GREEN SEWAGE WORKS.

Date completed and brought into operation	1888.
Engineer	R. Horsfall, Halifax.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	70 houses.
Average daily flow of sewage in dry weather	2,450 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, part of surface water is admitted.
Number of water closets in area drained	None.
LAND.	
Total area	Do.
Whether underdrained, and how?	Do.
Nett area upon which sewage can be treated	Do.
TANKS.	
Number and total capacity	Do.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	3 filters 30 super. yards.
Construction	Coke. 3 feet deep.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	Rented at £6 per year.
Laying out of land	
Tanks	
Filters	£90.

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	£2 12 0	£2 12 0	£2 12 0
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 3; Unsatisfactory 19

Analyses: Above limit –; Below limit –

Appendix 4.

HUNSLET RURAL DISTRICT.—MIDDLETON SEWAGE WORKS.

Date completed and brought into operation	November, 1898.
Engineer	Sam Shaw, C.E., Dewsbury.
Whether sanctioned by L.G.B.	No. Money not borrowed.
Area and population or number of houses drained	72 houses at present.
Average daily flow of sewage in dry weather	About 6,000 gallons in 24 hours.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage. Surface water not included, except from roofs, yards, &c.
Number of water closets in area drained	
LAND.	
Total area	No land is used, but plenty might be had, if required.
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Six. Total average area=472 square yards.
Construction	3 "coarse, composed of broken bricks, and 3 "fine, composed of coke breeze (pea size).
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently on Dibdin's system.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	20 times the dry weather flow at least.
COST OF—	
Land	Leased at £25 per annum.
Laying out of land	
Tanks	
Filters	Filters alone cost £240. Outfall works altogether cost £460.

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 1 / Unsatisfactory —

Analyses { Above limit ... – / Below limit ... –

TADCASTER RURAL DISTRICT.—HOLLINGHURST VILLAGE, ALLERTON BYWATER, SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	About 3 years ago.
Engineer	Mr. James Blackburn, C.E.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	About 50 houses. Population 250.
Average daily flow of sewage in dry weather	About 1,250 gallons daily.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. None.
Number of water closets in area drained	None.
LAND.	
Total area	About one rood.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	Only through filter beds.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	None.
Quantity	
How added	
FILTERS.	
Number and total area	Two filters. 18 feet square by 3 feet deep each.
Construction	Built of brick. Charged with chequers, coke breeze and sand.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. Not on Dibdin's method—on Mr. Denham's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One inlet sewer only.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	None.
Proportion of flow in sewer to average flow when storm overflows begin to act	Little or no difference, as there is no surface water connected to sewers.
COST OF—	
Land	Messrs. T. & R. W. Bowers are the lessors of the land
Laying out of land	No.
Tanks	No.
Filters	About £200 in laying main sewer and building filter beds.

	1895.	1896.	1897.
SLUDGE.			
Amount		About 2 tons.	About same as 1896.
How dealt with		Spread on land.	
Cost, or		About £2.	
Return		Nil.	
PRODUCE.			
Crops		No accounts are kept.	
Value			
WORKING EXPENSES.			
Labour		5s. a week.	
Chemicals		Coke breeze £5.	
Pumping			

Reports of Inspectors {Satisfactory ... – / Unsatisfactory 6}

Analyses {Above limit / Below limit}

Appendix 4.

TADCASTER RURAL DISTRICT.—GARFORTH SEWAGE WORKS.

Date completed and brought into operation	About 27 years ago.
Engineer	Messrs. Towlers, of Leeds.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	About 452 houses. Population about 2,260.
Average daily flow of sewage in dry weather	About 11,000 gallons daily.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Surface water partly included.
Number of water closets in area drained	About 30.
LAND.	
Total area	One acre.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	About ½ acre.
TANKS.	
Number and total capacity	*Six were first made, are now filters.
Used all together, or in series	Two at a time.
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	About 5 tons a year.
How added	One cake always standing in stream of sewage.
FILTERS.	
Number and total area	*Six. About 30 yards long, 2 yards wide, 5 feet deep.
Construction	Peat moss and coke breeze.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. Not on Dibdin's method—Mr. Wm. Green's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One inlet and 2 outlets, top and bottom of beds.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	No. One wooden sluice.
Proportion of flow in sewer to average flow when storm overflows begin to act	When wet there will be 20 gallons of storm water for one gallon of sewage.
COST OF—	
Land	£2,700.
Laying out of land	
Tanks	
Filters	£50 spent in present filters when made.

	1895.	1896.	1897.
SLUDGE.			
Amount		60 tons.	60 tons.
How dealt with		Sold.	Sold.
Cost, or		Peat moss £18 3 6	£18 3 6
Return		For manure nil.	£14 16 6
PRODUCE.			
Crops		Grass.	Grass.
Value		7*s.* 6*d.*	7*s.* 6*d.*
WORKING EXPENSES.			
Labour		£52 0 0	£52 0 0
Chemicals		£11 1 10	£11 1 10
Pumping			

Reports of Inspectors { Satisfactory ... 1; Unsatisfactory 16

Analyses { Above limit ... 2; Below limit ... —

Appendix 4

TADCASTER RURAL DISTRICT.—NEW MICKLEFIELD SEWAGE WORKS.

Date completed and brought into operation	About 7 years ago. No date kept.
Engineer	Mr. Charles Houfton, C.E.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	About 171 houses, with a population of 855.
Average daily flow of sewage in dry weather	About 8,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. No.
Number of water closets in area drained	None.
LAND.	
Total area	About one rood.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	Only through the filters.
TANKS.	
Number and total capacity	No.
Used all together, or in series	No.
Whether flow of sewage continuous, or time allowed for settlement	No.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	One cake always standing in sewage stream.
How added	Cake added whenever required.
FILTERS.	
Number and total area	Four. 18 feet square, 3 feet deep, each.
Construction	Built of brick. Charged with chequers, coke breeze, and sand.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	One bed used every fourth week, or when required. Not on Dibdin's method—on Mr. Denham's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One line of sewers only.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	None.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	The Micklefield Coal Co. Ld. are lessors of land.
Laying out of land	
Tanks	
Filters	Four filters cost about £120, or £30 each.

	1895.	1896.	1897.
SLUDGE.			
Amount			About 12 tons.
How dealt with			Carted on land
Cost, or			No accounts kept.
Return			Do.
PRODUCE.			
Crops			Do.
Value			Do
WORKING EXPENSES.			
Labour			18s. per week for man.
Chemicals			£11 a year and making beds.
Pumping			£20 once a year.

Reports of Inspectors {Satisfactory ... – / Unsatisfactory –}

Analyses {Above limit ... – / Below limit ... –}

Appendix 4.

TADCASTER RURAL DISTRICT.—NEWTHORPE SEWAGE WORKS.

Date completed and brought into operation	August, 1893.
Engineer	Mr. Robinson, the owner.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	About 100 inhabitants, or 21 houses.
Average daily flow of sewage in dry weather	About 300 gallons daily.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic only. No.
Number of water closets in area drained	None.
LAND.	
Total area	About 20 square yards.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	Nil.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	None.
Quantity	
How added	
FILTERS.	
Number and total area	Two filters, about 9 feet square each 3 feet deep.
Construction	Chequers, coke breeze, and sand.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. Not Dibdin's method—Mr. Denham's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	No.
Proportion of flow in sewer to average flow when storm overflows begin to act	No.
COST OF—	
Land	Nil. Filters built on owner's land.
Laying out of land	Nil.
Tanks	Nil.
Filters	About £42 for building filters and laying sewer.

	1895.	1896.	1897.
SLUDGE.			
Amount			About $\frac{1}{2}$ ton for 1 year.
How dealt with			Deposited in gardens.
Cost, or			No account kept.
Return			Do.
PRODUCE.			
Crops			Garden produce.
Value			No account kept.
WORKING EXPENSES.			
Labour			About £2 a year.
Chemicals			Coke and sand £2 a year.
Pumping			

Reports of Inspectors { Satisfactory ... 8; Unsatisfactory – }

Analyses { Above limit ... –; Below limit ... – }

WHARFEDALE RURAL DISTRICT. COOKRIDGE AND IDA HOSPITALS' SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	98.	(Information not supplied by Authority.)
Engineer	W. Spinks.	
Whether sanctioned by L.G.B.	No.	
Area and population or number of houses drained		
Average daily flow of sewage in dry weather		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.	
Number of water closets in area drained		
LAND.		
Total area	3 acres.	
Whether underdrained, and how?		
Nett area upon which sewage can be treated		
TANKS.		
Number and total capacity		
Used all together, or in series		
Whether flow of sewage continuous, or time allowed for settlement		
CHEMICALS.		
Nature	None.	
Quantity	Do.	
How added	Do.	
FILTERS.		
Number and total area	3 filters.	
Construction	Ashes.	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.	Dibdin's. Takes 1½ days to fill tank...
STORM OVERFLOWS.		
Number on line of sewers and at outfall works	None.	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.	
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.	
COST OF—		
Land		
Laying out of land		
Tanks		
Filters		

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 2; Unsatisfactory ... —

Analyses: Above limit ... ; Below limit ... —

Appendix 4.

FILTRATION THROUGH LAND.

BALBY-WITH-HEXTHORPE URBAN DISTRICT. BALBY SEWAGE WORKS.

Date completed and brought into operation	About 1882.
Engineer	The late B. S. Brundell.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	About 400 acres. Population 2,300.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	
LAND.	
Total area	11 acres.
Whether underdrained, and how?	Underdrained.
Nett area upon which sewage can be treated	10 acres.
TANKS.	
Number and total capacity	One.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Used to receive sewage from the low level section and pumped out.
CHEMICALS.	
Nature	None used.
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	Cannot ascertain. Works carried out many years before district constituted an Urban District.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	A small amount is taken out of tank periodically, and put on land about.		
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	The farm is let to a tenant at a yearly rental of £25.		
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping	About £60 a year.		

Reports of Inspectors: Satisfactory ... 17; Unsatisfactory –

Analyses: Above limit ... –; Below limit ... –

Appendix 4.

BARNSLEY URBAN DISTRICT.—BARNSLEY SEWAGE WORKS.

Date completed and brought into operation	July 17th, 1877.
Engineer	John Bailey Denton, C.E.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	About 2,000 acres and 8,000 houses.
Average daily flow of sewage in dry weather	1,250,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, mixed with trade refuse from dye, bleach, and printing works and breweries. Some surface water is admitted.
Number of water closets in area drained	About 2,000.
LAND.	
Total area	96 acres.
Whether underdrained, and how?	Yes, at a depth of from 4 to 6 feet.
Nett area upon which sewage can be treated	55 acres.
TANKS.	
Number and total capacity	2. Only screening and road detritus.
Used all together, or in series	Together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Lime and alumino-ferric. Since July, 1898.
Quantity	About five grains each per gallon.
How added	Milk of lime and alumino-ferric slabs.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	This is uncertain.
COST OF—	
Land	£23,955 15s. 0d.
Laying out of land	£6,022 7s. 9d.
Tanks	Included in the above.
Filters	None.

	1895.	1896.	1897.
SLUDGE.			
Amount	All distributed in the furrows on the land.		
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Mangolds, beans, swedes, rye grass, parsnips, carrots, beet root, cabbages, willows, oats, cauliflowers savoys.		
Value	£484 19s. 3d.		
WORKING EXPENSES.			
Labour	£644 19s. 11d.		
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... - ; Unsatisfactory 26 }

Analyses { Above limit ... - ; Below limit ... 3 }

Appendix 4.

CASTLEFORD URBAN DISTRICT.—CASTLEFORD SEWAGE WORKS.

Date completed and brought into operation	
Engineer	Malcolm Paterson and W. Wheater, Engineers.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	564 acres. 3,250 houses.
Average daily flow of sewage in dry weather	Approximately, 300,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water drainage adopted in part.
Number of water closets in area drained	
LAND.	
Total area	$12\frac{1}{2}$ acres.
Whether underdrained, and how?	Yes. 3 inch tiles.
Nett area upon which sewage can be treated	11 acres.
TANKS.	
Number and total capacity	No tanks, chemicals, or filters in use.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Three.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Ordinary.
Proportion of flow in sewer to average flow when storm overflows begin to act	Not ascertained.
COST OF—	
Land	
Laying out of land	And easements, £5,500.
Tanks	£1,600.
Filters	None.
SLUDGE.	Do.

	1895.	1896.	1897.
Amount			
How dealt with	Given away to farmers.		
Cost, or			
Return			
PRODUCE.			
Crops	Grass, value of no consideration.		
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Report of Inspectors { Satisfactory ... 8; Unsatisfactory 5 }

Analyses { Above limit 2; Below limit — }

Appendix 4.

CLECKHEATON URBAN DISTRICT.—SCHOLES SEWAGE WORKS.

Date completed and brought into operation	1890.
Engineer	Messrs. Woodhead.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1,700. 420 houses.
Average daily flow of sewage in dry weather	30,474 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Partly, but a scheme has just been sanctioned to take out the greater portion.
Number of water closets in area drained	6.
LAND.	
Total area	10 acres.
Whether underdrained, and how?	No, but scheme under consideration.
Nett area upon which sewage can be treated	9 acres.
TANKS.	
Number and total capacity	Nil.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Nil.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	None at present.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£1,000.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Grass.	Grass.	Grass.
Value	£18 0 0	£18 0 0	£18 0 0
WORKING EXPENSES.			
Labour			£1 1s. 0d. per week.
Chemicals			
Pumping			

Reports of Inspectors {Satisfactory ... 18; Unsatisfactory 3}

Analyses {Above limit ... -; Below limit ... -}

Appendix 4.

DEWSBURY BOROUGH URBAN DISTRICT.—DEWSBURY SEWAGE WORKS.

Date completed and brought into operation	1883.		
Engineer	J. Bailey Denton.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	Area 1,468 acres. Population 30,000. Houses 7,350.		
Average daily flow of sewage in dry weather	1¼ millions.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water, part only.		
Number of water closets in area drained	3,281.		
LAND.			
Total area	Farm 168 acres; 61 acres filtration, 12 acres broad irrigation.		
Whether underdrained, and how?	Yes. By open jointed pipes.		
Nett area upon which sewage can be treated	73 acres.		
TANKS.			
Number and total capacity	No storage or treatment tanks.		
Used all together, or in series	Do.		
Whether flow of sewage continuous, or time allowed for settlement	Do.		
CHEMICALS.			
Nature	None used.		
Quantity	Do.		
How added	Do.		
FILTERS.			
Number and total area	No artificial filters in use.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Storm water overflows not in use		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.		
COST OF—			
Land	£18,809 purchase money.		
Laying out of land	And cost of pumping station £21,200.		
Tanks			
Filters			
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Crops raised: mangolds, cabbages, oats, rye grass, willows, &c. and nearly the whole is consumed by Corporation stock.		
Value			
WORKING EXPENSES			
Labour	Not kept separate from farming, so cannot give cost of labour for sewage treatment.		
Chemicals			
Pumping	£594	£746	£640

Reports of Inspectors { Satisfactory... 25; Unsatisfactory

Analyses { Above limit 9; Below limit –

Appendix 4.

DONCASTER BOROUGH URBAN DISTRICT.—LOW PASTURE SEWAGE WORKS.

Date completed and brought into operation	1892.
Engineer	William H. R. Crabtree.
Whether sanctioned by L.G.B.	No money borrowed for the purpose.
Area and population or number of houses drained	About 4,000 population.
Average daily flow of sewage in dry weather	80,000 gallons per day.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water included.
Number of water closets in area drained	200.
LAND.	
Total area	141 acres.
Whether underdrained, and how?	Underdrained. 4 feet deep, one chain interval.
Nett area upon which sewage can be treated	100 acres.
TANKS.	
Number and total capacity	Two screening tanks.
Used all together, or in series	Independently at two separate outfalls
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two at outfall works, on to land. None on line of sewers.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	33 to 1.
COST OF—	
Land	The land belonged to the Corporation.
Laying out of land	£1,800.
Tanks	
Filters	

	1895	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	£26 per annum.		
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 7; Unsatisfactory – }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

DONCASTER BOROUGH URBAN DISTRICT.—SANDALL SEWAGE WORKS.

Date completed and brought into operation	1873.
Engineer	The late B. S. Brundell, C.E., in consultation with the late Sir Robert Rawlinson, C.E.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Portions of Doncaster and suburbs of Balby-with-Hexthorpe and Wheatley. Estimated sewage population 32,000.
Average daily flow of sewage in dry weather	640,000 gallons per day.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Chiefly domestic, breweries, and tanneries. Surface water included, except Hexthorpe and Wheatley.
Number of water closets in area drained	About 3,800.
LAND.	
Total area	288 acres.
Whether underdrained, and how?	About 30 acres undrained. This is being extended.
Nett area upon which sewage can be treated	237 acres. The balance near main roads being freed from sewage.
TANKS.	
Number and total capacity	One triangular tank not now used.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Three on line of sewers. One near outfall tank, but not used.
Construction—whether fixed side weirs, leaping weirs, or adjustible valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	About 5 to 1 gauged by capacity of one engine. About 10 to 1 gauged by capacity of both engines.
COST OF—	
Land	Not known. The land belonged to the Corporation.
Laying out of land	Do.
Tanks	Do.
Filters	Do.

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Let to a tenant and only known by him.		
Value	Do.		
WORKING EXPENSES.			
Labour	Do.		
Chemicals	Do.		
Pumping	About £600 a year.		

Reports of Inspectors { Satisfactory 15; Unsatisfactory –

Analyses { Above limit; Below limit

Appendix 4.

ECCLESHILL URBAN DISTRICT.—ECCLESHILL SEWAGE WORKS.

(Information not supplied by Authority.)

Date completed and brought into operation	1878.
Engineer	
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1,532 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade refuse.
Number of water closets in area drained	
LAND.	
Total area	80 acres.
Whether underdrained, and how?	Irrigation.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Grass.	Grass.	Grass.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors	Satisfactory ...	-
	Unsatisfactory ...	20
Analyses	Above limit ...	-
	Below limit ..	-

Appendix 4.

GREASBORO' URBAN DISTRICT.—GREASBORO' PROPER SEWAGE WORKS.

Date completed and brought into operation	1881. (Information not supplied by Authority.
Engineer	Brundell & Simmons.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	580 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	
LAND.	
Total area	$3\frac{1}{2}$ acres.
Whether underdrained, and how?	I.D.F.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One on line of sewers.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	None.		
Cost, or			
Return			
PRODUCE.			
Crops	Grass.	Grass.	Grass.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Report of Inspectors { Satisfactory ... 3; Unsatisfactory 20 }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

HARROGATE BOROUGH URBAN DISTRICT. HARROGATE SEWAGE WORKS.

Date completed and brought into operation.	1878.		
Engineer	E. Wareham Harry, C.E. (the then surveyor).		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	Area 1,287 acres. Population about 20,000.		
Average daily flow of sewage in dry weather	About 800,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Surface water is partially dealt with by separate drains, and further surface water drains are being constructed.		
Number of water closets in area drained	5,295.		
LAND.			
Total area	321 acres.		
Whether underdrained, and how?	Partially. Agricultural drain pipes.		
Nett area upon which sewage can be treated	293 acres.		
TANKS.			
Number and total capacity.	None.		
Used all together, or in series	Do.		
Whether flow of sewage continuous, or time allowed for settlement	Do.		
CHEMICALS.			
Nature	Do.		
Quantity	Do.		
How added	Do.		
FILTERS.			
Number and total area	Two bacteriological ones, each 5 yards × 4 yards. Experimental only.		
Construction	Brickwork and concrete.		
Whether used continuously or intermittently and (if the latter) whether on Dibdin's method	Intermittently. Dibdin's method.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Twelve.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves.	1 adjustable leaping weir. 9 fixed side weirs. 2 with pipe outlet in wall of manhole above top of sewer.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Varies considerably. Sewage 3 or 4 times diluted. In no case does storm overflow come into operation until sewer is two-thirds full.		
COST OF—			
Land	About £18,000.		
Laying out of land			
Tanks			
Filters			
	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	No sludge. Crude sewage run on to land.		
Cost, or	Man attending to sewage. £62 8s. 0d. per annum.		
Return			
PRODUCE.			
Crops	Roots, corn, rye grass, etc.		
Value	£6,456.	£4,987.	£6,112. Farm receipts.
WORKING EXPENSES.			
Labour	£5,035.	£6,107.	£5,843. Farm expenditure.
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 16; Unsatisfactory 8

Analyses: Above limit 1; Below limit

Appendix 4.

HARROGATE BOROUGH URBAN DISTRICT.—HIGH HARROGATE SEWAGE WORKS.

Date completed and brought into operation	1875.	(Information not supplied by Authority).	
Engineer			
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained			
Average daily flow of sewage in dry weather			
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes		
Number of water closets in area drained			
LAND.			
Total area	12 acres.		
Whether underdrained, and how?			
Nett area upon which sewage can be treated			
TANKS.			
Number and total capacity	None.		
Used all together, or in series			
Whether flow of sewage continuous, or time allowed for settlement			
CHEMICALS.			
Nature	Do.		
Quantity			
How added			
FILTERS.			
Number and total area	Do.		
Construction			
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method			
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Do		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves			
Proportion of flow in sewer to average flow when storm overflows begin to act			
COST OF—			
Land			
Laying out of land			
Tanks			
Filters			
	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Grass.	Grass.	Grass.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 14; Unsatisfactory 5

Analyses { Above limit; Below limit

Appendix 4.

IDLE URBAN DISTRICT.—IDLE SEWAGE WORKS.

Date completed and brought into operation	About November, 1894.
Engineer	Messrs. W. B. Woodhead & Sons.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	760 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Only where not possible to get into old drains.
Number of water closets in area drained	50.
LAND.	
Total area	22 acres.
Whether underdrained, and how?	Underdrained.
Nett area upon which sewage can be treated	8 acres and 23 perches.
TANKS.	
Number and total capacity	Nil.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Beds.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittent downward filtration.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	1 leaping weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	The full amount including land, works, professional charges, and other expenses was £25,000.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	Nil.		
How dealt with	Do.		
Cost, or	Do.		
Return	Do.		
PRODUCE.			
Crops	Part of the land is let to Mr. Wilson, farmer, at a yearly rent of £32 (about 14 acres).		
Value		£19 15s. 8d.	£22 15s. 10d.
WORKING EXPENSES.			
Labour	Including all expenses for seed, &c. £79 7s. 4d.	£144 12s. 4½d.	£153 14s. 10d.
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 9 / Unsatisfactory 15

Analyses { Above limit 3 / Below limit 1

Appendix 4.

KEIGHLEY BOROUGH URBAN DISTRICT.—KEIGHLEY SEWAGE WORKS.

Date completed and brought into operation	11th December 1894.
Engineer	W. H. Hopkinson, A.M.I.C.E., Borough Engineer.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	25,000 population.
Average daily flow of sewage in dry weather	780,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic and trade mixed. Surface water included. Manufacturers treat before turning into sewer.
Number of water closets in area drained	
LAND.	
Total area	49½ acres under treatment, 80½ acres of additional land is used as ordinary farm.
Whether underdrained, and how?	Yes, by 6 inch pipes, 66 feet apart and 5 feet deep.
Nett area upon which sewage can be treated	40 acres.
TANKS.	
Number and total capacity	Two. 640 cubic feet. These are to intercept large solids.
Used all together, or in series	Used alternately.
Whether flow of sewage continuous, or time allowed for settlement	A few days are allowed for liquid to drain off before sludge is removed.
CHEMICALS.	
Nature	None used.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	One of 240 yards at level of coke.
Construction	Dug out of solid ground, filled with 20 inches of coke of various sizes.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	It is used only for the night flow of sewage between 10 p.m. and 6 a.m., when the composition is chiefly subsoil water.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None at works or on outfall sewer.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	One fixed side weir. 4 leaping weirs on intercepting sewer and various small ones.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£125 per acre.
Laying out of land	£12,500. Farm buildings £2,500.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	What little there is, is put on adjoining lands.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals	None used.		
Pumping	None required.		

Reports of Inspectors {Satisfactory... 34, Unsatisfactory 10}

Analyses {Above limit 2, Below limit –}

Appendix 4.

KEIGHLEY BOROUGH URBAN DISTRICT.—UTLEY SEWAGE WORKS.

Date completed and brought into operation	March, 1891.
Engineer	B. Hopkinson & Co.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	
LAND.	
Total area	4½ acres.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	4 acres.
TANKS.	
Number and total capacity	Two. 2,250 cubic feet.
Used all together, or in series	Used alternately.
Whether flow of sewage continuous, or time allowed for settlement	One is in use whilst the other is being emptied.
CHEMICALS.	
Nature	None used.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£405 } Without Engineer's and legal charges.
Laying out of land	£160 }
Tanks	£100 }
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Farm let at a yearly rent of £4 10*s*. 0*d*.		
Value	Do.		
WORKING EXPENSES.			
Labour	Do.		
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 16; Unsatisfactory – }

Analyses { Above limit –; Below limit – }

Appendix 4.

MIRFIELD URBAN DISTRICT.—MIRFIELD SEWAGE WORKS.

Date completed and brought into operation	Partly in operation, not yet completed.
Engineer	Frederick Herbert Hare.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	2,000 houses drained.
Average daily flow of sewage in dry weather	150,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic only. No.
Number of water closets in area drained	200.
LAND.	
Total area	32 acres.
Whether underdrained, and how?	11 acres underdrained.
Nett area upon which sewage can be treated	25 acres at present, other leased out.
TANKS.	
Number and total capacity	Plans for tank arrangement and further underdrainage works have been sent to Local Government Board, and a public inquiry held.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One at Ledgard Bridge that cannot be used, also one at pumping station in case of breakdown.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Leaping weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	One-third of sewage gravitates to farm and is not affected by storm overflows. Other is retained in tank sewer and cannot rise to overflow unless pumps are standing 2 days.
COST OF—	
Land	£4,000.
Laying out of land	£700.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Oats and willows.	Oats and willows.	Oats and willows.
Value	£150	£90	£62.
WORKING EXPENSES.			
Labour	£70	£110	£110.
Chemicals			
Pumping	£200	£200	£200.

Reports of Inspectors { Satisfactory ... 4; Unsatisfactory 9

Analyses { Above limit; Below limit

Appendix 4.

RIPON CITY URBAN DISTRICT.—RIPON SEWAGE WORKS.

Date completed and brought into operation	20th October 1896.
Engineer	Messrs. Preston & Johnson, 14, The Exchange, Bradford.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	About 1,000 acres. 1,800 houses.
Average daily flow of sewage in dry weather	300,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included ?	Mixed with trade effluent. A large proportion.
Number of water closets in area drained	587.
LAND.	
Total area	30 acres purchased, but only 12 acres laid out.
Whether underdrained, and how ?	9 inch pipes laid under the paths 6 feet below beds
Nett area upon which sewage can be treated	$8\frac{1}{2}$ acres.
TANKS.	
Number and total capacity	One straining tank only (8,000 gallons).
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None used.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	The land is laid out in level plots ($\frac{3}{4}$ acre each).
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Used intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Six on line of sewers, none at outfall.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	All fixed weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	At least 10 times.
COST OF—	
Land	About £150 per acre.
Laying out of land	About £2,450 for the above-mentioned 12 acres.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount		80 tons.	72 tons.
How dealt with	Used on land not laid out (as manure) and by neighbouring farmers.		
Cost, or	Nil.		
Return	Do.		
PRODUCE.			
Crops	Willows, let to willow grower.		
Value	£13 per annum rental.		
WORKING EXPENSES.			
Labour	£20 per annum for emptying tank, removing sludge, and trimming banks and paths.		
Chemicals	Nil.		
Pumping	£30 per annum for pumping sewage from low lying district		

Reports of Inspectors { Satisfactory 12; Unsatisfactory – }

Analyses { Above limit –; Below limit – }

ROYSTONE URBAN DISTRICT.—CROSS LANE SEWAGE WORKS.

Date completed and brought into operation	1895.
Engineer	Joseph Latham, Barnsley.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	30 houses.
Average daily flow of sewage in dry weather	About 1,200 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic only. Surface water slight.
Number of water closets in area drained	None.
LAND.	
Total area	About 2 acres.
Whether underdrained, and how?	Underdrained with tiles.
Nett area upon which sewage can be treated	1½ acres.
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land, Laying out of land, Tanks, Filters	£840, including sewerage.

	1895.	1896.	1897.
SLUDGE.			
Amount	All dealt with on land and treated into same.		
How dealt with	Do.		
Cost, or	Do.		
Return	Do.		
PRODUCE.			
Crops	Nil.		
Value	Do.		
WORKING EXPENSES.			
Labour, Chemicals, Pumping	Estimated, 5s. 0d. per week.		

Reports of Inspectors { Satisfactory 1, Unsatisfactory 2

Analyses { Above limit, Below limit

Appendix 4.

SKIPTON URBAN DISTRICT.—SKIPTON SEWAGE WORKS.

Date completed and brought into operation	1876.		
Engineer	Baldwin Latham, M.I.C.E.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	4,245 acres. About 12,000 population. About 2,300 houses.		
Average daily flow of sewage in dry weather	Not known and cannot well be ascertained.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic and trade, with surface water included.		
Number of water closets in area drained	Nearly all houses have water closets.		
LAND.			
Total area	About 53 acres.		
Whether underdrained, and how?	Part 4 feet 6 × 4 feet tiles.		
Nett area upon which sewage can be treated	50 acres.		
TANKS.			
Number and total capacity	Two small tanks.		
Used all together, or in series	Worked together.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	None.		
Quantity	Do.		
How added	Do.		
FILTERS.			
Number and total area	No filters, but a grating through which sewage passes continuously.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	There is only one storm overflow on the farm. It has no valve, but a board is fixed to adjust the flow.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.		
COST OF—			
Land	£15,607.		
Laying out of land	£9,880.		
Tanks			
Filters			
	1895.	1896.	1897.
SLUDGE.			
Amount	This is carted away by farmers in the district, nothing is received or paid in respect of same.		
How dealt with	Do.		
Cost, or	Do.		
Return	Do.		
PRODUCE.			
Crops	Grass turnips, oats,	Grass, turnips, oats, &c.	Grass, turnips, oats &c.
Value	£415 14s. 2d.	£436 17s. 10d.	£387 0s. 6d.
WORKING EXPENSES.			
Labour	£320 8s. 5d.	£339 4s. 2d.	£363 15s. 6d.
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 8; Unsatisfactory ... 39 ... Analyses: Above limit ... 1; Below limit ... 4

Appendix 4.

WOMBWELL URBAN DISTRICT.—WOMBWELL SEWAGE WORKS.

Date completed and brought into operation	January, 1886, for the first contract.
Engineer	The Board's Surveyor, Jno. Robinson.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	In the first instance only such part of Wombwell village as emptied into the canal.
Average daily flow of sewage in dry weather	Cannot say.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. No.
Number of water closets in area drained	None when works were completed. Waste water closets now beginning to be used.
LAND.	
Total area	16 acres.
Whether underdrained, and how?	Yes, by 6 inch sanitary tubes (about 16 feet apart) to main carriers.
Nett area upon which sewage can be treated	13 acres.
TANKS.	
Number and total capacity	No tanks in original scheme. Increase of population caused additional land, also tanks, necessary. Works now going on.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	No tanks yet completed. When completed time will be allowed for settlement.
CHEMICALS.	
Nature	Filters not yet ready.
Quantity	
How added	
FILTERS.	
Number and total area	There will be 16 tanks at the old farm, area 511 square yards, and 8 tanks at the Hemingfield farm, area 212 square yards.
Construction	Brick in cement and concrete.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Will be intermittent.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Three.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Leaping weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Being short of land for the work required, produce has not been a consideration for a long time, purification of the sewage as far as possible being the only aim.		
Value			
WORKING EXPENSES.			
Labour	£169	£149	£132.
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 2; Unsatisfactory 16

Analyses: Above limit –; Below limit –

Appendix 4.

WORSBORO' URBAN DISTRICT.—WORSBORO' DALE SEWAGE WORKS.

Date completed and brought into operation	1882.
Engineer	W. Senior, Esq., Barnsley.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1,490.
Average daily flow of sewage in dry weather	29,800 gallons (estimated).
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Some surface water included.
Number of water closets in area drained	24 W.C. 40 slop water closets.
LAND.	
Total area	16 acres 3 roods 13 perches.
Whether underdrained, and how?	Underdrained 5 feet 6 inches deep (sanitary pipes).
Nett area upon which sewage can be treated	14½ acres.
TANKS.	
Number and total capacity	3. Tanks will hold 68 hours' flow of sewage.
Used all together, or in series	All together.
Whether flow of sewage continuous, or time allowed for settlement	Part continuous. Largest portion allowed to settle.
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	Leased.
Laying out of land	About £3,200.
Tanks	(About £3,200.)
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Used on land as manure.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			
— ...			

Reports of Inspectors: Satisfactory ... 13; Unsatisfactory ... 2

Analyses: Above limit .. –; Below limit .. –

Appendix 4.

WORSBORO' URBAN DISTRICT.—BIRDWELL SEWAGE WORKS.

Date completed and brought into operation	1884.
Engineer	W. Senior, Esq., Surveyor, Barnsley.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	245 houses.
Average daily flow of sewage in dry weather	5,000 gallons (estimated).
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water partly included.
Number of water closets in area drained	8 slop water closets.
LAND.	
Total area	2 acres 1 rood 38 perches.
Whether underdrained, and how?	Underdrained. 5 feet deep (sanitary pipes).
Nett area upon which sewage can be treated	1¾ acres.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	One-twelfth.
COST OF—	
Land	Leased.
Laying out of land	£450
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	On land as manure.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	Wages to man in charge 7s. 6d. per week, he taking in addition all produce, and making what he can of it.		
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 12; Unsatisfactory ... 7

Analyses { Above limit ... –; Below limit ... –

BARNSLEY RURAL DISTRICT.—CARLTON SEWAGE WORKS.

Date completed and brought into operation	1893. (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1,978 acres. Population (1891) 1,401.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	
LAND.	
Total area	One acre.
Whether underdrained, and how?	I.D.F.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.	No supervision pending new works.		
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory –; Unsatisfactory 12 }

Analyses { Above limit –; Below limit – }

Appendix 4

BOWLAND RURAL DISTRICT.—GISBURN SEWAGE WORKS.

Date completed and brought into operation	About the beginning of 1896.
Engineer	H. A. Johnson, C.E.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Area 1,876 acres. Population of township 444. Living in district about 350. Houses drained 71.
Average daily flow of sewage in dry weather	About 3,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water not included.
Number of water closets in area drained	35.
LAND.	
Total area	4 acres.
Whether underdrained, and how?	Yes.
Nett area upon which sewage can be treated	4 acres.
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Sewage purified by broad irrigation.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Open carriers with grips.
Proportion of flow in sewer to average flow when storm overflows begin to act	No storm overflow.
COST OF—	
Land	Sewers and all complete, £2,103.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.	None.	In 1896 and 1897 the sewage land was let to a tenant, who managed and took the crops at £5 per year.	
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour		Flushing sewers. £1 16s. 4d.	Flushing sewers, planting willows, &c., in 189‾ £9 10s. 1d.
Chemicals			
Pumping	None.		

Reports of Inspectors { Satisfactory ... 7; Unsatisfactory —

Analyses { Above limit ... –; Below limit ... –

DONCASTER RURAL DISTRICT.—LOVERSALL SEWAGE WORKS.

Date completed and brought into operation	August, 1894.
Engineer	C. C. Barras.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	120.
Average daily flow of sewage in dry weather	600 to 700 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	None.
LAND.	
Total area	100 feet × 25 feet.
Whether underdrained, and how?	Yes. 4 inch and 3 inch pipes, 21 fee .
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	One man £2 per year.		
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 1 / Unsatisfactory

Analyses { Above limit ... – / Below limit ... –

Appendix 4.

GREAT OUSEBURN RURAL DISTRICT.—ACOMB SEWAGE WORKS.

Date completed and brought into operation	1880.
Engineer	Charles Hornsey, York.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Area, 1,439 acres. Population, 2,181. Houses drained 480.
Average daily flow of sewage in dry weather	34,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage. No.
Number of water closets in area drained	90.
LAND.	
Total area	10 acres.
Whether underdrained, and how?	Underdrained every 11 yards.
Nett area upon which sewage can be treated	About 9 acres.
TANKS.	
Number and total capacity	Nil.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	Rent of £30 a year paid. Land on lease.
Laying out of land	Various sums have been spent under this head from time to time.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	The land was let at £20 a year to a local farmer up to September, 1896.		Mangolds and potatoes.
Value			Nil.
WORKING EXPENSES.			
Labour			
Chemicals			Labour, &c., £205.
Pumping			

Reports of Inspectors { Satisfactory ... 4; Unstatisfactory ... 6 } ... Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

HEMSWORTH RURAL DISTRICT.—MONKTON ROW, HAVERCROFT, SEWAGE WORKS.

Date completed and brought into operation	1st July, 1898.
Engineer	T. H. Richardson.
Whether sanctioned by L.G.B.	Paid out of current rates.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	3,000 gallons approximately.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. No trade refuse. Back yards and roofs only.
Number of water closets in area drained	None.
LAND.	
Total area	½ acre.
Whether underdrained, and how?	4 inch unsocketted pipes.
Nett area upon which sewage can be treated	All the area available for irrigation.
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£100
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors {Satisfactory ... 4; Unsatisfactory .. —}

Analyses {Above limit . ; Below limit ...}

Appendix 4.

HEMSWORTH RURAL DISTRICT.—SHAFTON SEWAGE WORKS.

Date completed and brought into operation	1894.		
Engineer	T. H. Richardson		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained			
Average daily flow of sewage in dry weather			
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only		
Number of water closets in area drained	None.		
LAND.			
Total area	3 roods 13 perches.		
Whether underdrained, and how?	Yes 4 inch unsocketted pipes.		
Nett area upon which sewage can be treated			
TANKS.			
Number and total capacity	None.		
Used all together, or in series	Do.		
Whether flow of sewage continuous, or time allowed for settlement	Do.		
CHEMICALS.			
Nature	Do.		
Quantity	Do.		
How added	Do.		
FILTERS.			
Number and total area	Do.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Do.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.		
COST OF—			
Land	Lease for 30 years at £8 6s. 6d. per annum.		
Laying out of land			
Tanks			
Filters			
		1896.	1897.
SLUDGE.			
Amount			
How dealt with	None.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			
WORKING EXPENSES.			
Labour	£3 6s. 0d. per quarter, including Shafton Two Gates.		
Chemicals	None.		
Pumping	Do		

Reports of Inspectors: Satisfactory ... 4; Unsatisfactory ... 12

Above limit ... 1; Below limit ... –

Appendix 4.

KIVETON PARK RURAL DISTRICT.—HARTHILL SEWAGE WORKS.

Date completed and brought into operation	About 1890.
Engineer	
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	500 population.
Average daily flow of sewage in dry weather	5,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	None.
LAND.	
Total area	1½ acres.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	1½ acres.
TANKS.	
Number and total capacity	None.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	12 hours' flow.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	£20.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Ploughed in.	Ploughed in.	Ploughed in.
Cost, or			
Return			
PRODUCE.			
Crops	Grass.	Grass	Grass.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 10; Unsatisfactory ... – }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

KIVETON PARK RURAL DISTRICT.—FIRVALE SEWAGE WORKS.

Date completed and brought into operation	Last alteration, October, 1896. Original scheme, 1879.		
Engineer	W. Atkinson.		
Whether sanctioned by L.G.B.	Original scheme, Yes. Additions, No.		
Area and population or number of houses drained	500 population.		
Average daily flow of sewage in dry weather	5,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.		
Number of water closets in area drained	None.		
LAND.			
Total area	4½ acres.		
Whether underdrained, and how?	Not where in irrigation.		
Nett area upon which sewage can be treated	2½ acres.		
TANKS.			
Number and total capacity	Only a catch pit. Flow for 12 hours only. Continuous.		
Used all together, or in series			
Whether flow of sewage continuous, or time allowed for settlement			
CHEMICALS.			
Nature	Alumino-ferric.		
Quantity	Do.		
How added	Do.		
FILTERS.			
Number and total area	None.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Do.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.		
COST OF—			
Land	On lease.		
Laying out of land			
Tanks	£10.		
Filters	None.		
	1895.	1896.	1897.
SLUDGE.			
Amount	Always dug into ground.		
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Turnips, peas, beans, barley, celery, oats, cabbages, &c.		
Value	Sold locally.		
WORKING EXPENSES.			
Labour	£10.		
Chemicals	£3.		
Pumping			

Reports of Inspectors: Satisfactory ... 9; Unsatisfactory 1

Analyses: Above limit –; Below limit –

Appendix 4.

KIVETON PARK RURAL DISTRICT.—WALES BAR SEWAGE WORKS.

Date completed and brought into operation	March, 1898.
Engineer	W. Atkinson.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	200 population.
Average daily flow of sewage in dry weather	2,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. 12 hours' flow.
Number of water closets in area drained	None.
LAND.	
Total area	1 acre 20 perches.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	1 acre 20 perches.
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	£10.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Not previously dealt with.		
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 10; Unsatisfactory ... 1

Analyses: Above limit ... -; Below limit ... -

Appendix 4.

KNARESBOROUGH RURAL DISTRICT.—BILTON-ON-THE-HILL SEWAGE WORKS.

Date completed and brought into operation	1898.
Engineer	D. Balfour, C.E.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	130.
Average daily flow of sewage in dry weather	7,800.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Surface water from roofs and back yards only.
Number of water closets in area drained	40.
LAND.	
Total area	9 acres.
Whether underdrained, and how?	Not underdrained.
Nett area upon which sewage can be treated	8½ acres.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One storm overflow.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	12 times.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 4; Unsatisfactory ... –

Analyses { Above limit ...; Below limit ...

KNARESBOROUGH RURAL DISTRICT.—BILTON NEW PARK SEWAGE WORKS.

Date completed and brought into operation	
Engineer	Mr. Harwood Hall.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	329.
Average daily flow of sewage in dry weather	33,000.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only and the surface water from roofs and back yards only.
Number of water closets in area drained	203.
LAND.	
Total area	12 acres.
Whether underdrained, and how?	Partly underdrained about 3 feet deep.
Nett area upon which sewage can be treated	11 acres.
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 10; Unsatisfactory 6 }

Analyses { Above limit ... 1; Below limit ... – }

Appendix 4.

KNARESBOROUGH RURAL DISTRICT.—FARNHAM SEWAGE WORKS.

Date completed and brought into operation	1895. (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	118 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included ?	Domestic.
Number of water closets in area drained	None.
LAND.	
Total area	One acre.
Whether underdrained, and how ?	No.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... – ; Unsatisfactory ... – }

Analyses { Above limit ... – ; Below limit ... – }

Appendix 4.

KNARESBOROUGH RURAL DISTRICT.—OATLANDS SEWAGE WORKS.

Date completed and brought into operation	March, 1893.
Engineer	Arthur Smithies.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	225.
Average daily flow of sewage in dry weather	22,500.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only and surface water from roofs and back yards only.
Number of water closets in area drained	175.
LAND.	
Total area	12 acres.
Whether underdrained, and how?	Partly underdrained about 3 feet deep.
Nett area upon which sewage can be treated	11 acres.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	None.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 14; Unsatisfactory ... 1 } ... { Above limit ... 1; Below limit ... }

Appendix 4.

KNARESBOROUGH RURAL DISTRICT.—STARBECK SEWAGE WORKS.

Date completed and brought into operation	
Engineer	Mr. Harwood Hall, C.E.
Whether sanctioned by L.G.B.	Yes
Area and population or number of houses drained	567.
Average daily flow of sewage in dry weather	56,000.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Surface water from roofs and back yards only.
Number of water closets in area drained	510.
LAND.	
Total area	13 acres.
Whether underdrained, and how?	Partly underdrained 3 feet deep.
Nett area upon which sewage can be treated	13 acres.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side.
Proportion of flow in sewer to average flow when storm overflows begin to act	Full bore.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 8 / Unsatisfactory 2 }

Analyses { Above limit ... 1 / Below limit ... }

Appendix 4.

PATELEY BRIDGE RURAL DISTRICT.—PATELEY BRIDGE SEWAGE WORKS.

Date completed and brought into operation	
Engineer	H. A. Johnson, The Exchange, Bradford.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Acreage about 3,000. Population between 2,000 and 3,000.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water excluded.
Number of water closets in area drained	Under 100.
LAND.	
Total area	4 acres.
Whether underdrained, and how?	
Nett area upon which sewage can be treated	Between 3 and 4 acres.
TANKS.	
Number and total capacity	Two.
Used all together, or in series	Alternately.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement.
CHEMICALS.	
Nature	Nil.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Six beds.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittent.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£600.
Laying out of land	£6,400.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 5; Unsatisfactory ... – }

Analyses { Above limit ... ; Below limit ... – }

Appendix 4.

PENISTONE RURAL DISTRICT.—CAWTHORNE, CLAY HALL, SEWAGE WORKS.

Date completed and brought into operation	Completed March, 1898.
Engineer	Under direction of Estate Clerk of the Works.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	48 houses.
Average daily flow of sewage in dry weather	Not known.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Surface water included, but new sewer contemplated for sewage only. To include 35 more houses.
Number of water closets in area drained	None.
LAND.	
Total area	2 acres.
Whether underdrained, and how?	Not underdrained
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Alternate surface irrigation.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Storm overflow at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	£2 a year for supervision of irrigation.		
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory 6; Unsatisfactory 1

Analyses: Above limit; Below limit

Appendix 4.

ROTHERHAM RURAL DISTRICT.—ASTON SEWAGE WORKS.

Date completed and brought into operation	1893.		
Engineer	G. & D. Jennings.		
Whether sanctioned by L.G.B.	Partly.		
Area and population or number of houses drained	1,200 estimated population.		
Average daily flow of sewage in dry weather	18,000 gallons estimated.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, roof and yard water. There is also a considerable amount of infiltration water.		
Number of water closets in area drained			
LAND.			
Total area	1 acre.		
Whether underdrained, and how?	No.		
Nett area upon which sewage can be treated	⅞ of an acre.		
TANKS.			
Number and total capacity	One. 1,500 gallons.		
Used all together, or in series			
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	Nil.		
Quantity			
How added			
FILTERS.			
Number and total area	Nil.		
Construction			
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method			
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Nil.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves			
Proportion of flow in sewer to average flow when storm overflows begin to act			
COST OF—			
Land	£5 per annum on a 21 years' lease.		
Laying out of land	Nil.		
Tanks	About £20.		
Filters	Nil.		
	1895.	1896.	1897.
SLUDGE.			
Amount	Nil.	Nil.	Nil.
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Let until this month to a sub-tenant. Will shortly be planted with osiers.		
Value			
WORKING EXPENSES.			
Labour	Nil.	Nil.	Nil.
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 7; Unsatisfactory ... 10 } ... Analyses { Above limit ... -; Below limit ... - }

Appendix 4.

ROTHERHAM RURAL DISTRICT.—SWALLOW NEST SEWAGE WORKS.

Date completed and brought into operation	1880.
Engineer	D. Jennings.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Estimated population 1,000.
Average daily flow of sewage in dry weather	Not ascertained.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic and surface water only.
Number of water closets in area drained	None.
LAND.	
Total area	$1\frac{3}{4}$ acres.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	$1\frac{1}{2}$ acres.
TANKS.	
Number and total capacity	2 cesspools, which cannot be called tanks.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	None.
Quantity	
How added	
FILTERS.	
Number and total area	None.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£5 per acre on a 21 years' lease.
Laying out of land	Not ascertainable.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	None.	None.	None.
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Sublet to a market gardener.		
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... – ; Unsatisfactory – }

Analyses { Above limit ... – ; Below limit ... – }

Works admittedly unsatisfactory. New scheme in hand.

Appendix 4.

ROTHERHAM RURAL DISTRICT.—WHISTON SEWAGE WORKS.

Date completed and brought into operation	1877.
Engineer	D. Jennings.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1,500 estimated population.
Average daily flow of sewage in dry weather	Cannot be ascertained on account of the enormous amount of water getting in out of the river bed.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic and surface water included.
Number of water closets in area drained	None.
LAND.	
Total area	1 acre.
Whether underdrained, and how?	Every 20 feet.
Nett area upon which sewage can be treated	¾ of an acre.
TANKS.	
Number and total capacity	None.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	None.
Quantity	
How added	
FILTERS.	
Number and total area	None.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	Not ascertainable.
COST OF—	
Land	£10 per annum on a 21 years' lease.
Laying out of land	Not ascertainable.
Tanks	Nil.
Filters	Nil.

	1895.	1896.	1897.
SLUDGE.			
Amount	Nil.	Nil.	Nil.
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			Not planted until this year.
Value			
WORKING EXPENSES.			
Labour	£20 per annum.	£20 per annum.	£20 per annum.
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 12; Unsatisfactory ... 5

Analyses { Above limit ...; Below limit ...

Appendix 4.

SEDBERGH RURAL DISTRICT.—DENT SEWAGE WORKS.

Date completed and brought into operation	November, 1898.
Engineer	R. Edgar Horsfall, Halifax.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 283. Houses drained 86.
Average daily flow of sewage in dry weather	1,250 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. No surface water is included.
Number of water closets in area drained	Three.
LAND.	
Total area	$3\frac{1}{3}$ acres.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	About 3 acres
TANKS.	
Number and total capacity	Nil.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£450.
Laying out of land	About £10.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 2; Unsatisfactory ... – } ... { Above limit ... ; Below limit ... }

Appendix 4.

SETTLE RURAL DISTRICT.—LONG PRESTON SEWAGE WORKS.

Date completed and brought into operation	November, 1898.
Engineer	Richard Armistead, Assoc.M.Inst.C.E., Bingley.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Approximate population 750.
Average daily flow of sewage in dry weather	22,800 gallons per day.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Partly.
Number of water closets in area drained	
LAND.	
Total area	5 acres.
Whether underdrained, and how?	Yes. 6 inch and 4 inch earthenware pipes.
Nett area upon which sewage can be treated	4 acres.
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£750.
Laying out of land	Estimated cost £608.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			No crops.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 8; Unsatisfactory -

Analyses { Above limit -; Below limit -

Appendix 4.

SETTLE RURAL DISTRICT.—NEWBY SEWAGE WORKS.

Date completed and brought into operation	December, 1897.
Engineer	T. A. Foxcroft, Surveyor to the Settle R.D. Council.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Approximate population, 100.
Average daily flow of sewage in dry weather	3,000.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included ?	Domestic. Partly.
Number of water closets in area drained	3 acres 3 roods
LAND.	
Total area	No.
Whether underdrained, and how ?	3 acres 3 roods.
Nett area upon which sewage can be treated	One. 6 × 4.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	Leased for 21 years from 21st September, 1897, at rent £3 per annum.
Laying out of land	£15.
Tanks	£6.
Filters	None.

	1895.	1896	1897.
SLUDGE.			
Amount			Nil.
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			Nil.
Value			
WORKING EXPENSES.			
Labour			Nil.
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 7 / Unsatisfactory... –

Analyses { Above limit ... – / Below limit ...

Appendix 4.

SETTLE RURAL DISTRICT.—CLAPHAM SEWAGE WORKS.

Date completed and brought into operation	November, 1898.
Engineer	Richard Armistead, Assoc.M.Inst.C.E., Bingley.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Approximate population 280.
Average daily flow of sewage in dry weather	8,400.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Partly.
Number of water closets in area drained	
LAND.	
Total area	2 acres.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	$1\frac{3}{4}$ acres.
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£300.
Laying out of land	£224.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			Not yet let.
Value			
WORKING EXPENSES.			Nil.
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 7; Unsatisfactory ... – }

Analyses { Above limit ... ; Below limit ... – }

Appendix 4.

SETTLE RURAL DISTRICT.—HIGH BENTHAM SEWAGE WORKS.

Date completed and brought into operation	1882.
Engineer	Edward Frith, Bakewell.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	
Number of water closets in area drained	
LAND.	
Total area	5 acres 3 roods 9 erches
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	5 acres.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£1,180.
Laying out of land	£40 expended in 1898.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Broad irrigation.		
Cost, or			
Return			
PRODUCE.			
Crops	Grass let for £15 per annum.		
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 12; Unsatisfactory ... }

Analyses { Above limit ... ; Below limit ... }

Appendix 4.

SETTLE RURAL DISTRICT.—LOW BENTHAM SEWAGE WORKS.

Date completed and brought into operation	1882.
Engineer	Edward Frith.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Approximate population 596.
Average daily flow of sewage in dry weather	20,000.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, mixed with silk washings. Yes
Number of water closets in area drained	
LAND.	
Total area	1 acre 3 roods 14 perches.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	1 acre 2 roods.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£120.
Laying out of land	Laid out in 1898 only at a cost of 100*l*.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			Planted with osiers in 1898.
Value			
WORKING EXPENSES.			
Labour			2*s*. 6*d*. per week.
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 11; Unsatisfactory ... 2

Analyses: Above limit ... –; Below limit ...

Appendix 4.

SETTLE RURAL DISTRICT.—INGLETON SEWAGE WORKS.

Date completed and brought into operation	1881.
Engineer	Wm. Goldsworth, Prescot, Lancashire.
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	Approximate population, 1,033.
Average daily flow of sewage in dry weather	40,000.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic and refuse from tannery. Yes.
Number of water closets in area drained	
LAND.	
Total area	3 acres and 35 perches.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	3 acres.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£280.
Laying out of land	Laid out in 1898 at a cost of £100.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Broad irrigation.		
Cost, or			
Return			
PRODUCE.			
Crops	Grass let at £10 10s. per annum.		
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Farming			

Reports of Inspectors { Satisfactory ... 14; Unsatisfactory ... 1 }

Analyses { Above limit ...; Below limit ... }

Appendix 4.

SKIPTON RURAL DISTRICT.—GARGRAVE SEWAGE WORKS.

Date completed and brought into operation	1894.	(Information not supplied by Authority.)
Engineer		
Whether sanctioned by L.G.B.	Yes.	
Area and population or number of houses drained	2,540 acres.	Population (1891) 1,296.
Average daily flow of sewage in dry weather		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.	
Number of water closets in area drained		
LAND.		
Total area	4 acres.	
Whether underdrained, and how?	Irrigation.	
Nett area upon which sewage can be treated		
TANKS.		
Number and total capacity	None.	
Used all together, or in series	Do.	
Whether flow of sewage continuous, or time allowed for settlement	Do.	
CHEMICALS.		
Nature	Do.	
Quantity	Do.	
How added	Do.	
FILTERS.		
Number and total area	Do.	
Construction	Do.	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.	
STORM OVERFLOWS.		
Number on line of sewers and at outfall works	Do.	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.	
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.	
COST OF—		
Land		
Laying out of land		
Tanks		
Filters		

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Garden Produce.	Garden Produce.	Garden Produce.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 24; Unsatisfactory — }

Analyses { Above limit ... –; Below limit ... }

Appendix 4.

SKIPTON RURAL DISTRICT.—GLUSBURN SEWAGE WORKS.

Date completed and brought into operation	1893.		(Information not supplied by Authority.)
Engineer			
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	1,525 acres. Population (1891) 1,942.		
Average daily flow of sewage in dry weather			
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.		
Number of water closets in area drained			
LAND.			
Total area	5 acres.		
Whether underdrained, and how?	I.D.F.		
Nett area upon which sewage can be treated			
TANKS.			
Number and total capacity	None.		
Used all together, or in series	Do.		
Whether flow of sewage continuous, or time allowed for settlement	Do.		
CHEMICALS.			
Nature	Do.		
Quantity	Do.		
How added	Do.		
FILTERS.			
Number and total area	Do.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	One at outfall works.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Adjustable valve.		
Proportion of flow in sewer to average flow when storm overflows begin to act			
COST OF—			
Land			
Laying out of land			
Tanks			
Filters			
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Domestic vegetables.		
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 13; Unsatisfactory 30

Analyses { Above limit ... –; Below limit ... –

SKIPTON RURAL DISTRICT.—THORNTON-IN-CRAVEN SEWAGE WORKS.

Date completed and brought into operation	1896.	(Information not supplied by Authority.)
Engineer		
Whether sanctioned by L.G.B.	Yes.	
Area and population or number of houses drained	87 houses.	
Average daily flow of sewage in dry weather		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.	
Number of water closets in area drained		
LAND.		
Total area	One acre.	
Whether underdrained, and how?		
Nett area upon which sewage can be treated	½ acre. I.D.F.	
TANKS.		
Number and total capacity	None.	
Used all together, or in series	Do.	
Whether flow of sewage continuous, or time allowed for settlement	Do.	
CHEMICALS.		
Nature	Do.	
Quantity	Do.	
How added	Do.	
FILTERS.		
Number and total area	Do.	
Construction	Do.	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.	
STORM OVERFLOWS.		
Number on line of sewers and at outfall works	Do.	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.	
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.	
COST OF—		
Land		
Laying out of land		
Tanks		
Filters		

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 23; Unsatisfactory ... 1 }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

TADCASTER RURAL DISTRICT.—SHERBURN SEWAGE WORKS.

Date completed and brought into operation	About 25 years ago.
Engineer	Mr. George Morley.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	About 251 houses. Population about 1,250.
Average daily flow of sewage in dry weather	About 3,765 gallons per day.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water from yards only.
Number of water closets in area drained	About 6 W.C.
LAND.	
Total area	7 acres of land.
Whether underdrained, and how?	Yes. Land tiles 3 inches.
Nett area upon which sewage can be treated	7 acres.
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Flowing on land daily, and filters through the soil.
CHEMICALS.	
Nature	None.
Quantity	Do
How added	Do
FILTERS.	
Number and total area	Do.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Not on Dibdin's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	About one-third more sewage than ordinary when wet.
COST OF—	
Land	Land leased for 30 years, at £21 a year.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			No record kept.
How dealt with			On the land only.
Cost, or			No account kept.
Return			Do.
PRODUCE.			
Crops			Rhubarb.
Value			No account kept.
WORKING EXPENSES.			
Labour			Present tenant works the land and pays the rent for use of land, £21 a year.
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 5; Unsatisfactory ... – }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

WAKEFIELD RURAL DISTRICT.—SMALLEY BIGHT SEWAGE WORKS.

Date completed and brought into operation	Earley in 1896.
Engineer	Frank Massie, Assoc.M.Inst.C.E., Wakefield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1,885 acres. 8,000 population (estimated.)
Average daily flow of sewage in dry weather	No record. Probably 160,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. No.
Number of water closets in area drained	Comparatively few. No exact record.
LAND.	
Total area	31 acres 3 roods 15 perches, of which 15 acres is sub-let to a farmer.
Whether underdrained, and how?	Only partially by trunk subsoil drains.
Nett area upon which sewage can be treated	12 acres are at present available, but this can be increased to 24 acres when necessary.
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	No record.
COST OF—	
Land	£5,965 1*s.* 11*d.*
Laying out of land	(15 acres only) £1,484 7*s.* 1*d.*
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops		Rye grass, oats, and mangolds.	Rye grass, wheat, and mangolds.
Value		£292.	£77.
WORKING EXPENSES.			
Labour		£95.	£87.
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 9 / Unsatisfactory

Analyses { Above limit ... 1 / Below limit ...

Appendix 4

WAKEFIELD RURAL DISTRICT.—SHITLINGTON SEWAGE WORKS.

Date completed and brought into operation	Early in 1897.
Engineer	Frank Massie, Assoc.M.Inst.C.E., Wakefield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	600 acres. 2,500 population.
Average daily flow of sewage in dry weather	No exact record. Probably 50,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water is excluded as far as possible.
Number of water closets in area drained	Very few.
LAND.	
Total area	6 acres 2 roods 5 perches.
Whether underdrained, and how?	Yes. By subsoil drains.
Nett area upon which sewage can be treated	5 acres 7 perches.
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	No record.
COST OF—	
Land	£1,100.
Laying out of land	No exact record.
Tanks	None.
Filters	Do.

	1895.	1896.	1897.
SLUDGE.			
Amount			None.
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			Rye grass and oats.
Value			£2
WORKING EXPENSES.			£32
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 11; Unsatisfactory ... 1

Analyses { Above limit ... –; Below limit ... –

Appendix 4.

WETHERBY RURAL DISTRICT.—WETHERBY SEWAGE WORKS.

Date completed and brought into operation	
Engineer	A. E. Preston, Bradford.
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	1,373 acres. 2,000 population. 468 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	
Number of water closets in area drained	About 35.
LAND.	
Total area	25½ acres.
Whether underdrained, and how?	Yes. Sanitary pipes.
Nett area upon which sewage can be treated	20 acres.
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One on line of sewer.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	Rented, £65 per year.
Laying out of land	Not known.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 6; Unsatisfactory 2

Analyses { Above limit ... ; Below limit .. –

1213.

Appendix 4.

WHARFEDALE RURAL DISTRICT.—ESHOLT SEWAGE WORKS.

Date completed and brought into operation	1898.	(Information not supplied by Authority.)
Engineer		
Whether sanctioned by L.G.B.	Yes.	
Area and population or number of houses drained	691 acres. 305 population.	
Average daily flow of sewage in dry weather		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic Yes.	
Number of water closets in area drained		
LAND.		
Total area	2 acres.	
Whether underdrained, and how?	I.D.F.	
Nett area upon which sewage can be treated	½ acres	
TANKS.		
Number and total capacity	None.	
Used all together, or in series	Do.	
Whether flow of sewage continuous, or time allowed for settlement	Do.	
CHEMICALS.		
Nature	Do.	
Quantity	Do.	
How added	Do.	
FILTERS.		
Number and total area	Do.	
Construction	Do.	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.	
STORM OVERFLOWS.		
Number on line of sewers and at outfall works	Do.	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.	
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.	
COST OF—		
Land		
Laying out of land		
Tanks		
Filters		

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Garden produce.		
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 13; Unsatisfactory — }

Analyses { Above limit ... –; Below limit ... – }

CHEMICAL PRECIPITATION OR SETTLEMENT.

ARDSLEY URBAN DISTRICT.—WOMBWELL ROAD SEWAGE WORKS.

Date completed and brought into operation	12th June, 1895.
Engineer	Mr. T. S. McCallum, Manchester.
Whether sanctioned by L.G.B.	No (paid for out of current rates).
Area and population or number of houses drained	About 20 houses.
Average daily flow of sewage in dry weather	About 800 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	
LAND.	
Total area	600 square yards.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	None, unless pumped.
TANKS.	
Number and total capacity	1 tank, 4 feet × 4 feet × 6 feet 3 inches deep. 625 gallons.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric at present.
Quantity	
How added	Basket in inlet channel.
FILTERS.	
Number and total area	No filter at present.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	About £20.
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			About 3 tons.
How dealt with			Put on land adjoining.
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			£5 per year.
Chemicals			1 ton per year. £2 15s.
Pumping			

Reports of Inspectors { Satisfactory ... 3; Unsatisfactory ... 2

Analyses { Above limit ... [illegible]; Below limit ... [illegible]

Appendix 4.

ECCLESHILL URBAN DISTRICT.—GREENGATES SEWAGE WORKS.

Date completed and brought into operation	1890. (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	566 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade waste.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	4 tanks. 85,351 gallons.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			
[illegible]			

Reports of Inspectors { Satisfactory ... 2; Unsatisfactory 29

Analyses { Above limit –; Below limit –

EMLEY URBAN DISTRICT.—THORNCLIFFE LANE SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	In use about 3 years.
Engineer	Mr. Sam Shaw prepared the plans for the tanks.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	About 55 houses. Population 275.
Average daily flow of sewage in dry weather	Not calculated.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	None.
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	(Precipitating). 2 tanks. Capacity not calculated.
Used all together, or in series	Together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alum.-ferric.
Quantity	As required.
How added	Tablet in Chambers.
FILTERS.	
Number and total area	Nil.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	Not calculated.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Put on to the land.	Put on to the land.	Put on to the land.
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.	Not calculated separately. Done in surveyor's time. This is included in Smith's quarry expense.		
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 4; Unsatisfactory ... 1 }

Analyses { Above limit ... ; Below limit ... }

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Appendix 4.

GOLCAR URBAN DISTRICT.—APPLEYARD SEWAGE WORKS.

Date completed and brought into operation	About 17 years ago.
Engineer	John Hanson & Co.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	917 houses drained.
Average daily flow of sewage in dry weather	Varies very much.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade refuse. Surface water included.
Number of water closets in area drained	42.
LAND.	
Total area	No land treatment.
Whether underdrained, and how?	Do.
Nett area upon which sewage can be treated	Do.
TANKS.	
Number and total capacity	3 tanks. 30 feet × 24 feet, 3 feet 6 inches deep.
Used all together, or in series	All together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous
CHEMICALS.	
Nature	Alumino-ferric and lime.
Quantity	2 cwts. each per day.
How added	Automatic machine.
FILTERS.	
Number and total area	1 filter.
Construction	Natural.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	Cannot say.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			20 tons per week.
How dealt with			Taken by farmers.
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			25*s.* per week
Chemicals			8*s.* per day.
Pumping			Gravitation.

Reports of Inspectors. { Satisfactory ... 4; Unsatisfactory ... 11

Analyses { Above limit ... ; Below limit ... 2

GUISELEY URBAN DISTRICT.—GUISELEY SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	July, 1888.
Engineer	Preston & Johnson, Bradford.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 4,800. Area 1,554 acres.
Average daily flow of sewage in dry weather	270,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	All sewage, domestic and trade. No.
Number of water closets in area drained	
LAND.	
Total area	4 acres.
Whether underdrained, and how?	Yes. Land tiles laid 5 yards apart and 1 yard deep.
Nett area upon which sewage can be treated	1 acre.
TANKS.	
Number and total capacity	Eleven. 1 reception, 6 precipitation = 344,000 gallons; 1 aerating = 170,000 gallons; 3 mud tanks.
Used all together, or in series	All used together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	Average, 2 tons per week.
How added	Slabs placed in channel and sewage dissolves it.
FILTERS.	
Number and total area	None. Plans are now in hand for providing filters to be worked on Dibdin's method.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	1 at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs, unmovable.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£1,500.
Laying out of land	£1,900.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	500 loads.	600 loads.	800 loads.
How dealt with	We give 4*d.* per load to anyone fetching it.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory .. 6; Unsatisfactory 18

Analyses: Above limit –; Below limit 3

Appendix 4.

HALIFAX COUNTY BOROUGH.—SALTERHEBBLE SEWAGE WORKS.

(Information not supplied by Authority.)

Date completed and brought into operation	1869.
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	8,209 acres. Population (1891), 83,109.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade refuse. Yes.
Number of water closets in area drained	
LAND.	
Total area	None.
Whether underdrained, and how?	Do.
Nett area upon which sewage can be treated	Do.
TANKS.	
Number and total capacity	11 tanks. 314,260 gallons.
Used all together, or in series	2 sets worked alternately.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	
How added	Put into channel.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Several on line of sewers. 2 at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Various kinds. Some fixed, some moveable.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			40 tons a week.
How dealt with	Carted away by farmers.		
Cost, or			
Return			
PRODUCE.			
Crops	None.	None.	None.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... – ; Unsatisfactory ... 26

Analyses { Above limit ... ; Below limit ...

Appendix 4

HIPPERHOLME URBAN DISTRICT.—BAILIFFE BRIDGE WEST SEWAGE WORKS.

Date completed and brought into operation	Early in 1879.
Engineer	Richard Horsfall, Halifax.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	About 900 acres. Population about 2,675.
Average daily flow of sewage in dry weather	About 90,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Only one small tannery in addition to sewage. Yes.
Number of water closets in area drained	176 to houses with closets.
LAND.	
Total area	6,352 yards.
Whether underdrained, and how?	
Nett area upon which sewage can be treated	None.
TANKS.	
Number and total capacity	6. 36 feet × 14 feet, 30 inches deep.
Used all together, or in series	Series, 3 at a time.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	16 tons a year.
How added	Put in in slabs in mouth of drain.
FILTERS.	
Number and total area	None.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	About double quantity.
COST OF—	
Land	The entire cost of land and sewerage works was £9,000.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			80 loads per year.
How dealt with			Farmers.
Cost, or			
Return			About 40 loads per year.
PRODUCE.			
Crops	Nil.		
Value			
WORKING EXPENSES.			
Labour			£20.
Chemicals			£40.
Pumping			None.

Reports of Inspectors: Satisfactory ... 3; Unsatisfactory ... 2

Analyses: Above limit ... –; Below limit ... –

Appendix 4.

HOYLAND NETHER URBAN DISTRICT.—TINKER LANE SEWAGE WORKS.

(Information not supplied by Authority.)

Date completed and brought into operation	1893.
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	362 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	2 tanks.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	
How added	Put in channel.
FILTERS.	
Number and total area	None
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Put on to land.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... –; Unsatisfactory 14

Analyses: Above limit –; Below limit -

LEEDS COUNTY BOROUGH.—LEEDS SEWAGE WORKS

Appendix 4.

Date completed and brought into operation	Now being extended.
Engineer	City Engineer—Thos. Hewson.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	About eighty thousand houses.
Average daily flow of sewage in dry weather	Fifteen million gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Yes.
Number of water closets in area drained	From a population of about 250,000.
LAND.	
Total area	27 acres.
Whether underdrained, and how?	Occupied by tanks, sludge lagoons, buildings, &c.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	12 old tanks, $2\frac{1}{2}$ millions; 7 new tanks, 3 millions. Will be used all together, except that some of the 12 old ones will be used for experiments for some time to come.
Used all together, or in series	Will be used all together in series and with continuous flow.
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	Lime.
Quantity	Now using three grains per gallon.
How added	As milk of lime in pump well.
FILTERS.	
Number and total area	Experiments being made with biological beds.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One at outfall works, great number in other places.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	All three ways.
Proportion of flow in sewer to average flow when storm overflows begin to act	Variable average, perhaps one-third.

	1895.	1896.	1897.
COST OF—			
Land			
Laying out of land			
Tanks			
Filters			
SLUDGE.			
Amount			
How dealt with			
Cost, or	See Lord Mayor's Report, December, 1898.		
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... / Unsatisfactory

Analyses { Above limit ... – / Below limit ... -

Appendix 4.

SANDAL URBAN DISTRICT.—SANDAL SEWAGE WORKS.

Date completed and brought into operation	1885.
Engineer	W. Crutchley, C.E., Wakefield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Area 1,616 acres. Population 5,082.
Average daily flow of sewage in dry weather	40,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included ?	Domestic. Surface water partly.
Number of water closets in area drained	About 100.
LAND.	
Total area	About 11,000 square yards.
Whether underdrained, and how ?	No.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	3 tanks. Capacity 460,000 gallons.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement.
CHEMICALS.	
Nature	Lime
Quantity	About 40 tons per annum.
How added	Mixed with sewage as flowing to tanks.
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Plans now being prepared for Dibdin's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£6,859 8s. 11d.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Given away.	Given away.	Given away.
Cost, or			
Return			
PRODUCE.			
Crops	Garden produce.	Garden produce.	Garden produce.
Value			
WORKING EXPENSES.			
Labour	£58 19 0	£52 2 6	£55 16 3
Chemicals	£11 10 4	£12 7 10	£19 16 8
Pumping			

Reports of Inspectors { Satisfactory .. ; Unsatisfactory ... 10

Analyses { Above limit ... - ; Below limit ... -

Appendix 4.

YEADON URBAN DISTRICT.—KIRK LANE SEWAGE WORKS.

Date completed and brought into operation	
Engineer	McLandsbro & Preston
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	101 houses.
Average daily flow of sewage in dry weather	10,000 gallons per day.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage. No.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	2 tanks.
Used all together, or in series	Altogether.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Lime.
Quantity	2 tons per month.
How added	Placed in channel.
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Not affected by storm.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	Leasehold, £10 per year.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Spread on land.	Spread on land.	Spread on land.
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	Cost included with Yeadon works		
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 1; Unsatisfactory ... 20 }

Analyses { Above limit ... –; Below limit ... 2 }

Appendix 4.

HEMSWORTH RURAL DISTRICT.—HOUGHTON PARVA SEWAGE WORKS

Date completed and brought into operation	31st January, 1895.
Engineer	
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only.
Number of water closets in area drained	About 4.
LAND.	
Total area	About 1 rood.
Whether underdrained, and how?	
Nett area upon which sewage can be treated	Not used.
TANKS.	
Number and total capacity	
Used all together, or in series	Covered tank, about 12 feet × 8 feet.
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	A small quantity of alumino-ferric.
Quantity	
How added	
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	Lease for 38 years at £5 per annum.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Given away.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			

WORKING EXPENSES.	
Labour	£8 per annum, including Middlecliffe.
Chemicals	None.
Pumping	Do.

Reports of Inspectors { Satisfactory ... – ; Unsatisfactory 2 }

Analyses { Above limit ... – ; Below limit ... }

ROTHERHAM RURAL DISTRICT.—CONCRETE, BRAMPTON BIERLOW, SEWAGE WORKS. Appendix 4.

Date completed and brought into operation	1896.
Engineer	B. Godfrey, A.M.Inst.C.E.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	106 houses.
Average daily flow of sewage in dry weather	8,000 gallons estimated.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, roof and yard water only.
Number of water closets in area drained	Nil.
LAND.	
Total area	1 acre. Effluent to colliery boilers.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	Nil.
TANKS.	
Number and total capacity	1 pair. 2,000 gallons each.
Used all together, or in series	Used together.
Whether flow of sewage continuous, or time allowed for settlement	Continuously.
CHEMICALS.	
Nature	Nil.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	1 on the line of sewer.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	44 times ordinary flow.
COST OF—	
Land	2*l.* per annum.
Laying out of land	Nil.
Tanks	90*l.*
Filters	Nil.

	1895.	1896.	1897.
SLUDGE.			
Amount			Not known.
How dealt with			Spread on land
Cost, or			Nil.
Return			Do.
PRODUCE.			
Crops			Do.
Value			Do.
WORKING EXPENSES.			
Labour			2*l.* 2*s.* 0*d.* per annum.
Chemicals			Nil.
Pumping			Do.

Report of Inspectors {Satisfactory ... – / Unsatisfactory 1}

Analyses {Above limit ... – / Below limit ... –}

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Appendix 4.

ROTHERHAM RURAL DISTRICT.—WENTWORTH SEWAGE WORKS.

Date completed and brought into operation	1895.		
Engineer	E. W. Ives.		
Whether sanctioned by L.G.B.	No.		
Area and population or number of houses drained	1,000 population estimated.		
Average daily flow of sewage in dry weather	15,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, and road water, surface water, and a good many field drains included.		
Number of water closets in area drained	Three.		
LAND.			
Total area	500 square yards.		
Whether underdrained, and how?	No.		
Nett area upon which sewage can be treated	None available.		
TANKS.			
Number and total capacity	1. Ives' patent, capacity unknown.		
Used all together, or in series			
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	14 cwt. alumino-ferric and alum cake answers fairly well to a million gallons. Others have been tried, but not so satisfactory.		
Quantity			
How added	Roughly broken in mixing race.		
FILTERS.			
Number and total area	None.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	1 at outfall works.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weir in line.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Twice ordinary flow.		
COST OF—			
Land	£2 per annum.		
Laying out of land	Nil.		
Tanks	£250.		
Filters	Nil.		
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount	About 4 cubic yards per month.	Do.	Do.
How dealt with	Carted on to land.	Do.	Do.
Cost, or	10s. per month.	Do.	Do.
Return	Nil.		
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	£7 16s. per annum.	Do.	Do.
Chemicals	£10 per annum.	Do.	Do.
Pumping	Nil.		

Reports of Inspectors { Satisfactory ... – ; Unsatisfactory ... 6 }

Analyses { Above limit ... – ; Below limit ... – }

ROTHERHAM RURAL DISTRICT.—HARLEY SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	1895.
Engineer	E. W. Ives.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	500 estimated population.
Average daily flow of sewage in dry weather	6,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic and road water only.
Number of water closets in area drained	None.
LAND.	
Total area	1,000 square yards.
Whether underdrained, and how?	Used to be, but has since been cut off.
Nett area upon which sewage can be treated	600 square yards.
TANKS.	
Number and total capacity	Ives' patent, capacity unknown.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric and alum cake, answers fairly well, others tried but not satisfactory.
Quantity	26 cwt. per million gallons, not allowing for rain water.
How added	Roughly broken in mixing race.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side of weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	Not known.
COST OF—	
Land	£2 per annum.
Laying out of land	Nil.
Tanks	£250.
Filters	Nil.

	1895.	1896.	1897.
SLUDGE.			
Amount	About 4 cubic yards per month.	Do.	Do.
How dealt with	Carted on to land.		
Cost, or	10*s*. per month.		
Return	Nil.		
PRODUCE.			
Crops	None.		
Value	Do.		
WORKING EXPENSES.			
Labour	£7 16*s*. per annum.		
Chemicals	£10 per annum.		
Pumping	Nil.		

Reports of Inspectors { Satisfactory ... 1; Unsatisfactory ... 10

Analyses { Above limit -; elow limit -

Appendix 4.

TODMORDEN RURAL DISTRICT.—HEPTONSTALL SEWAGE WORKS.

Date completed and brought into operation	1889.
Engineer	John Sutcliffe, Todmorden.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	212 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Only from roofs of houses.
Number of water closets in area drained	None.
LAND.	
Total area	About 2,200 square yards.
Whether underdrained, and how?	Yes, by agricultural pipes.
Nett area upon which sewage can be treated	About one-half.
TANKS.	
Number and total capacity	None.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric in slabs.
Quantity	About 20 lbs. per day.
How added	In manhole.
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	Leased, not purchased.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	No account kept.		
How dealt with	On adjoining land.		
Cost, or			
Return			
PRODUCE.			
Crops	Nil.		
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping	No pumping.		

Reports of Inspectors { Satisfactory ... 4; Unsatisfactory 8 }

Analyses { Above limit; Below limit – }

Appendix 4.

SETTLEMENT OR CHEMICAL PRECIPITATION, FOLLOWED BY FILTRATION THROUGH LAND.

ALTOFTS URBAN DISTRICT.—ALTOFTS SEWAGE WORKS.

Date completed and brought into operation	About February, 1880.		
Engineer	Mr. James Lumley, Bradford.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	1,690 acres. About 4,500.		
Average daily flow of sewage in dry weather	25,000 gallons per diem.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water partly included.		
Number of water closets in area drained	67		
LAND.			
Total area	4 acres 3 roods.		
Whether underdrained, and how?	Yes, with 6 inch earthenware pipes.		
Nett area upon which sewage can be treated	About $3\frac{1}{2}$ acres.		
TANKS.			
Number and total capacity	2. 15,000.		
Used all together, or in series	Together.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	None.		
Quantity	Do.		
How added	Do.		
FILTERS.			
Number and total area	Do.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Do.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.		
COST OF—			
Land			
Laying out of land			
Tanks			
Filters			
	1895.	1896.	1897.
SLUDGE.			
Amount	About 30 tons.	Same.	Same.
How dealt with	Used for manure.	Do.	Do.
Cost, or	Given away.	Do.	Do.
Return			
PRODUCE.			
Crops	Grass.	Do.	Do.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... / Unsatisfactory ... –   Analyses { Above limit ... / Below limit ... –

Works admittedly unsatisfactory. New scheme in hand.

Appendix 4.

ARDSLEY URBAN DISTRICT.—HOYLE MILL WORKS.

Date completed and brought into operation	
Engineer	Mr. Jos. Latham, Barnsley.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	About 200 houses drained.
Average daily flow of sewage in dry weather	About 3,500 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. No.
Number of water closets in area drained	7
LAND.	
Total area	
Whether underdrained, and how?	Yes.
Nett area upon which sewage can be treated	One acre for effluent by gravitation.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	About 5 tons per year.
How added	Basket in mixing channel.
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	About 7 times.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			20 tons.
How dealt with			Put into gardens and land adjoining.
Cost, or			
Return			Nil.
PRODUCE.			
Crops			Cabbage and other crops.
Value			
WORKING EXPENSES.			
Labour			£69 per year.
Chemicals			£13 15*s.* 0*d.* per year.
Pumping			Nil.

Reports of Inspectors: Satisfactory ... 15; Unsatisfactory 3

Analyses: Above limit ... –; Below limit ... 1

ARDSLEY EAST AND WEST URBAN DISTRICT.—TINGLEY SEWAGE WORKS.

Appendix 4

Date completed and brought into operation	1893.
Engineer	Frank Massie, Esq., C.E.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	183 houses.
Average daily flow of sewage in dry weather	18,252.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. From buildings.
Number of water-closets in area drained	10.
LAND.	
Total area	2 acres.
Whether underdrained, and how?	Part underdrained with land tiles 4 feet below surface.
Nett area upon which sewage can be treated	2 acres.
TANKS.	
Number and total capacity	2. 1,512 cubic feet.
Used all together, or in series	Both ways.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	None
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One on line of sewer.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	75 per cent.
COST OF—	Cannot say, Engineer has particulars
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.		10	10.
Amount			
How dealt with	Given to farmers.		
Cost, or	Nil.		
Return	Do.		
PRODUCE.			
Crops		Willows.	Willows and grass.
Value		£7 10 0.	£7 5 0.
WORKING EXPENSES.			
Labour	£30 0 0.	£30 0 0.	£30 0 0.
Chemicals	Nil.	Nil.	Nil
Pumping	Do.	Do.	Do

Reports of Inspectors { Satisfactory ... 19; Unsatisfactory ... 1

Analyses { Above limit ..; Below limit ..

Appendix 4.

ARDSLEY EAST AND WEST URBAN DISTRICT.—THE FALL SEWAGE WORKS.

Date completed and brought into operation	1888.
Engineer	Arthur Fawcett, Esq., C.E. The additions by Frank Massie, Esq., [C.E.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	380 houses.
Average daily flow of sewage in dry weather	36,430 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed. From buildings.
Number of water closets in area drained	30.
LAND.	
Total area	Two acres in 1894. 3 acres 9 perches was added.
Whether underdrained, and how?	Part underdrained with land tiles about 3 feet 6 inches below surface.
Nett area upon which sewage can be treated	4 acres.
TANKS.	
Number and total capacity	5 tanks, 11,232 cubic feet.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed.
CHEMICALS.	
Nature	Lime.
Quantity	15 cwts. per week.
How added	Through mixer by wind mill and water wheel.
FILTERS.	
Number and total area	3. 1,800 cubic feet.
Construction	Coke and sand.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. No.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	At works one.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Adjustable.
Proportion of flow in sewer to average flow when storm overflows begin to act	75 per cent.
COST OF—	
Land	
Laying out of land	£3,570.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	400	400	400
How dealt with	Given to farmers and 6*d.* per load with same.		
Cost, or	£10	£10	£10
Return	Nil	Nil.	Nil
PRODUCE.			
Crops	Grass.	Grass.	Grass.
Value		£1 15 0	£2 15 0
WORKING EXPENSES.			
Labour		£83 4 0	£83 4 0
Chemicals		£24 10 0	£28 1 4
Pumping			

Reports of Inspectors { Satisfactory ... 23; Unsatisfactory ... 1 }

Analyses { Above limit ... 1; Below limit .. }

ARDSLEY EAST AND WEST URBAN DISTRICT.—FENTON DAM OUTFALL SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	1894.
Engineer	Frank Massie, Esq., C.E.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	238 houses. 149 houses added in the New Scarboro' drainage.
Average daily flow of sewage in dry weather	34,920 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. From buildings.
Number of water closets in area drained	None.
LAND.	
Total area	5¾ acres.
Whether underdrained, and how?	Part underdrained with land tiles 4 feet below surface.
Nett area upon which sewage can be treated	4¾ acres.
TANKS.	
Number and total capacity	3. 8,640 cubic feet.
Used all together, or in series	All together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One on line of sewer.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	75 per cent.
COST OF—	Cannot say. Engineer has particulars.
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount		15 loads.	20 loads.
How dealt with	Put on land where sewage cannot be treated.		
Cost, or			
Return			
PRODUCE.			
Crops		Grass.	Grass.
Value		£2 0 0.	£3 0 0.
WORKING EXPENSES.			
Labour	£30 0 0.	£30 0 0.	£30 0 0.
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 19; Unsatisfactory ... }

Analyses { Above limi[t] •; Below limit ... 1 }

Appendix 4.

BAILDON URBAN DISTRICT.—CHARLESTOWN SEWAGE WORKS.

Date completed and brought into operation	1884. (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	50 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	
LAND.	
Total area	5 acres of garden.
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	One small catchpit.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Garden produce.	Garden produce.	Garden produce.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspector { Satisfactory ... 14; Unsatisfactory – }

Analyses { Above limit –; Below limit – }

BINGLEY URBAN DISTRICT.—HARDEN SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	1873 (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	Area 8,276 acres. 200 houses. Population 5,180 (1891).
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade waste.
Number of water closets in area drained	
LAND.	
Total area	Nominal irrigation.
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	Two small tanks.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do
Construction	Do
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors {Satisfactory ... 6; Unsatisfactory 11}

Analyses {Above limit .; Below limit ...}

Appendix 4.

BINGLEY URBAN DISTRICT.—CULLINGWORTH No. 1 SEWAGE WORKS.

Date completed and brought into operation	1873. (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	278 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	
LAND.	
Total area	Rough irrigation.
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	Two small tanks.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 8; Unsatisfactory ... 2 }

Analyses { Above limit ... ; Below limit ... 1 }

Appendix 4.

BURLEY-IN-WHARFEDALE URBAN DISTRICT.—BURLEY AND MENSTON JOINT SEWAGE WORKS.

Date completed and brought into operation	1896. (Information not supplied by Authority.)
Engineer	John Waugh, Esq.; H. A. Johnson, Esq.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	3,133 acres. 2,661 population (1891.)
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade refuse. Yes.
Number of water closets in area drained	
LAND.	
Total area	Six acres.
Whether underdrained, and how?	I.D.F.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	Two tanks.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Pumped on land and carted away.		
Cost, or			
Return			
PRODUCE.			
Crops	Garden produce.	None.	None.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 8; Unsatisfactory ... 16

Analyses: Above limit .. 4; Below limit ... 1

Appendix 4.

CALVERLEY URBAN DISTRICT.—CALVERLEY SEWAGE WORKS.

Date completed and brought into operation	Not yet complete. Have been in partial operation since 8th Feb. [1898.
Engineer	Mr. George Riley, Surveyor to the Council.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	30 to 40 acres. 440 houses.
Average daily flow of sewage in dry weather	15,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	26.
LAND.	
Total area	About 2 acres.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	Filtration not irrigation adopted.
TANKS.	
Number and total capacity	2. 3,900 cubic feet.
Used all together, or in series	Altogether.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	About 28 lbs. per day.
How added	Blocks placed in the current.
FILTERS.	
Number and total area	3,240 square feet.
Construction	12 inch of 2 inch clinker, 9 inch of ½ inch do., 9 inch of ⅜ and 6 inch of ¼ do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	2. On outfall.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	About one-twelfth.
COST OF—	
Land	Rented (farm of over 31 acres £100 per annum.)
Laying out of land	
Tanks	£160 17*s*. 5*d*.
Filters	Not quite complete.

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 12; Unsatisfactory 2

Analyses: Above limit ... –; Below limit ... –

Appendix 4.

CLECKHEATON URBAN DISTRICT.—OAKENSHAW SEWAGE WORKS.

Date completed and brought into operation	1890.
Engineer	John S. Ramsden.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	120.
Average daily flow of sewage in dry weather	10,278 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	One.
LAND.	
Total area	½ acre.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	About ½ acre.
TANKS.	
Number and total capacity	2. 2,017 cubic feet.
Used all together, or in series	Together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	Sufficient for precipitation.
How added	Placed in channel.
FILTERS.	
Number and total area	Run on the surface of the land and turned about as required.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Nil.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	5*l*. per annum.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	No record.	No record.	No record.
How dealt with	Given away.	Given away.	Given away.
Cost, or			
Return			
PRODUCE.			
Crops	Nil.	Nil.	Nil.
Value			
WORKING EXPENSES.			
Labour	About 20*l*.	About 20*l*.	About 20*l*.
Chemicals	5*l*.	5*l*.	5*l*
Pumping			

Reports of Inspectors { Satisfactory ... 29; Unsatisfactory 4 }

Analyses { Above limit –; Below limit – }

Appendix 4.

DODWORTH URBAN DISTRICT.—DODWORTH SEWAGE WORKS.

Date completed and brought into operation	May, 1893.
Engineer	Mr. John Wade, Pitt Street, Barnsley.
Whether sanctioned by L.G.B.	Yes. Date of sanction September 10th, 1891.
Area and population or number of houses drained	Area 1,916 acres. Population (in 1891) 3,106.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included ?	Domestic sewage. Surface water not included.
Number of water closets in area drained	12.
LAND.	
Total area	11 acres, of which about 2½ acres are laid out for the treatment of sewage.
Whether underdrained, and how ?	
Nett area upon which sewage can be treated	11 acres.
TANKS.	
Number and total capacity	Two tanks.
Used all together, or in series	One at a time.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement in tank.
CHEMICALS.	
Nature	None used.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	2½ acres are laid out in beds with drains.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Four.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	The land is leased by the District Council at an annual rent of £44.
Laying out of land; Tanks; Filters	(2½ acres). £963.

SLUDGE.	1895.	1896.	1897.
Amount			
How dealt with			
Cost, or			
Return			

PRODUCE. Crops; Value; **WORKING EXPENSES.** Labour; Chemicals; Pumping	The Sewage Farm was for a year or two from the commencement let to a neighbouring farmer, who paid the Council a rent of £10 a year, and undertook at his own expense the management of the farm, but for some years now it has been let to him *free of rent*, and he undertakes the management as before.

Reports of Inspectors: Satisfactory ... 12; Unsatisfactory ... 3

Analyses: Above limit ... –; Below limit ... –

Appendix 4.

ELLAND URBAN DISTRICT.—ELLAND SEWAGE WORKS.

Date completed and brought into operation	13th November 1897.
Engineer	M. Paterson, Esq., Bradford.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	10,000 population.
Average daily flow of sewage in dry weather	750,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic and trade. Yes.
Number of water closets in area drained	About 350.
LAND.	
Total area	12 acres.
Whether underdrained, and how?	Underdrained with tiles.
Nett area upon which sewage can be treated	About 11 acres.
TANKS.	
Number and total capacity	8 tanks. 600,000 gallons.
Used all together, or in series	All together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Lime and alumino-ferric.
Quantity	About 10 grains to 1 gallon.
How added	Lime is added in milk of lime, alumino-ferric in block.
FILTERS.	
Number and total area	11 acres.
Construction	Land filtration.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	6.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	Cannot say. Never seen them act in the heaviest storm, only when sewer was blocked.
COST OF—	
Land	Rented.
Laying out of land	£3,470.
Tanks	1,000.
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			Not working.
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 2; Unsatisfactory 36

Analyses: Above limit .. 2; Below limit ... 6

Appendix 4.

EMLEY URBAN DISTRICT.—SMITH'S QUARRY OR BROOM HALL SEWAGE WORKS.

Date completed and brought into operation	In use about two years.
Engineer	Nil.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	72, about. Population about 360.
Average daily flow of sewage in dry weather	Not gauged.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	None.
LAND.	
Total area	About 9 acres.
Whether underdrained, and how?	Yes. I believe by pipes.
Nett area upon which sewage can be treated	About 7 acres.
TANKS.	
Number and total capacity	4 tanks.
Used all together, or in series	All together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alum-ferric tablets.
Quantity	As required.
How added	In chambers.
FILTERS.	
Number and total area	We are now constructing bacteria tanks on Dibdin's system, which will be completed in a short time and the old tanks done away with.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	Not gauged.
COST OF—	
Land	Nil.
Laying out of land	£1 5*s*. per year.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			Not calculated.
How dealt with			Put on land I believe.
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			Work done in Surveyor's time. £3 4*s*. 1*d*.
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 2 / Unsatisfactory ... 1

Analyses { Above limit ... / Below limit ... –

Appendix 4.

HANDSWORTH URBAN DISTRICT.—SOAP HOUSE LANE, WOODHOUSE, SEWAGE WORKS.

(District No. 2.)

Date completed and brought into operation	At the end of 1896.
Engineer	W. H. Lancashire, C.E., Sheffield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 2,900.
Average daily flow of sewage in dry weather	34,800 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, and effluent from tannery.
Number of water closets in area drained	5 water-closets and several waste water-closets.
LAND.	
Total area	5 acres 2 roods 17 perches.
Whether underdrained, and how?	Subsoil drainage with sanitary pipes.
Nett area upon which sewage can be treated	4 acres 3 roods 9 perches.
TANKS.	
Number and total capacity	6 tanks hold 51,800 gallons.
Used all together, or in series	Three alternately.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric and lime.
Quantity	
How added	
FILTERS.	
Number and total area	Four filters in course of construction.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	Storm overflows not been required to act to the present.
COST OF—	
Land	£691 13 2.
Laying out of land	£435 17 0.
Tanks	£330 16 2.
Filters	Not completed.

	1895.	1896.	1897.
SLUDGE.			
Amount			120 tons per annum.
How dealt with			Given away.
Cost, or			
Return			
PRODUCE.			
Crops			Turnips, oats, cabbages and willows.
Value			£18 per annum.
WORKING EXPENSES.			
Labour			£81 per annum.
Chemicals			£40 per annum.
Pumping			

Reports of Inspectors: Satisfactory ... 4; Unsatisfactory ... 17

Analyses: Above limit ... ; Below limit ... 1

Appendix 4.

HANDSWORTH URBAN DISTRICT.—SOAP HOUSE LANE, WOODHOUSE MILL, SEWAGE WORKS. (District No. 1.)

Date completed and brought into operation	At the end of 1896.
Engineer	W. H. Lancashire, C.E., Sheffield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 1,250.
Average daily flow of sewage in dry weather	15,000 gallons in 24 hours.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Only from yards and roofs of houses.
Number of water closets in area drained	One.
LAND.	
Total area	1 acre 2 roods 29 perches.
Whether underdrained, and how?	Subsoil drainage with sanitary pipes.
Nett area upon which sewage can be treated	The whole.
TANKS.	
Number and total capacity	One tank, holds 26,600 gallons.
Used all together, or in series	Together.
Whether flow of sewage continuous, or time allowed for settlement	Intermittent.
CHEMICALS.	
Nature	Lime and alumino-ferric.
Quantity	One cwt. of each per day.
How added	The lime diluted with water before mixing, the alumino-ferric placed under the outfall pipe of pump.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£355 18 2
Laying out of land	£120 0 0
Tanks	£170 0 0
Filters	None.

	1895.	1896.	1897.
SLUDGE.			
Amount			100 tons per annum.
How dealt with			Given away.
Cost, or			None.
Return			Do.
PRODUCE.			
Crops			Willows and cabbages.
Value			Practically none.
WORKING EXPENSES.			
Labour			£63 0 0 per annum.
Chemicals			£39 7 6 per annum.
Pumping			£39 0 0 per annum.

Reports of Inspectors { Satisfactory ... 17; Unsatisfactory ... 2 }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

HANDSWORTH URBAN DISTRICT.—GREENWOOD LANE, WOODHOUSE, SEWAGE WORKS.

(District No. 2*a*.)

Date completed and brought into operation	At the end of 1896.
Engineer	W. H. Lancashire, C.E., Sheffield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 300.
Average daily flow of sewage in dry weather	3,600 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. To a very small extent (roofs and yards.)
Number of water closets in area drained	Two.
LAND.	
Total area	1 acre.
Whether underdrained, and how?	Subsoil drains with sanitary pipes.
Nett area upon which sewage can be treated	1 acre.
TANKS.	
Number and total capacity	One tank, capacity 10,000 gallons, 2 filters (originally two pre cipitation tanks.)
Used all together, or in series	Tank continuous. Filters alternately.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	Very small.
How added	Placed in inlet to tank.
FILTERS.	
Number and total area	Two.
Construction	Coke breeze and gravel.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittent, on Dibdin's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed front weir
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£100 0 0
Laying out of land	£115 16 7
Tanks	£81 12 7
Filters	About £30 0 0

	1895.	1896.	1897.
SLUDGE.			
Amount			Small.
How dealt with			On adjoining land.
Cost, or			Nil.
Return			Do.
PRODUCE.			
Crops			Willows.
Value			Nil.
WORKING EXPENSES.			
Labour			£26 per annum.
Chemicals			£5.
Pumping			

Reports of Inspectors { Satisfactory ... 13; Unsatisfactory ... 2 }

Analyses { Above limit ... –; Below limit ... – }

1213.

Appendix 4.

HANDSWORTH URBAN DISTRICT.—CALVERT ROAD, WOODHOUSE, SEWAGE WORKS.

(District No. 3.)

Date completed and brought into operation	At the end of 1896.
Engineer	W. H. Lancashire, C.E., Sheffield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 290.
Average daily flow of sewage in dry weather	3,480 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Entirely domestic. Only yards and roofs.
Number of water closets in area drained	None.
LAND.	
Total area	0 acres 3 roods 32 perches.
Whether underdrained, and how?	Subsoil pipes throughout.
Nett area upon which sewage can be treated	0 acres 3 roods 32 perches.
TANKS.	
Number and total capacity	One.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	Very small.
How added	In outfall sewer at tank.
FILTERS.	
Number and total area	Two.
Construction	Large and small coke.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently, on Dibdin's system
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Front weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£181 4 0
Laying out of land	£158 17 8
Tanks	£79 18 4
Filters	About £30

	1895.	1896.	1897.
SLUDGE.			
Amount			Small.
How dealt with			On the land.
Cost, or			
Return			
PRODUCE.			
Crops			Turnips.
Value			£2 per annum.
WORKING EXPENSES.			
Labour			£26 per annum.
Chemicals			£5 per annum.
Pumping			

Reports of Inspectors: Satisfactory ... 9; Unsatisfactory ... 1

Analyses: Above limit ... 1; Below limit ... –

Appendix 4.

HANDSWORTH URBAN DISTRICT.—NORMANTON HILL SEWAGE WORKS.
(District No. 4.)

Date completed and brought into operation	At the end of 1896.
Engineer	W. H. Lancashire, C.E., Sheffield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 1,655.
Average daily flow of sewage in dry weather	19,860 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	None.
LAND.	
Total area	4 acres 0 roods 26 perches.
Whether underdrained, and how?	Subsoil drains, sanitary pipes.
Nett area upon which sewage can be treated	4 acres.
TANKS.	
Number and total capacity	Four. Capacity 23,000 gallons.
Used all together, or in series	Used together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	One cwt. per diem.
How added	In chamber at tank head.
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weirs fixed.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	398*l.* 4*s.* 8*d.*
Laying out of land	307*l.* 13*s.* 8*d.*
Tanks	170*l.* 2*s.* 5*d.*
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			60 tons per annum.
How dealt with			Used on the land.
Cost, or			
Return			
PRODUCE.			
Crops			Oats and cabbages.
Value			10*l.* per annum.
WORKING EXPENSES.			
Labour			82*l.* per annum.
Chemicals			About 39*l.* per annum.
Pumping			

Reports of Inspectors {Satisfactory ... 17; Unsatisfactory 6}

Analyses {Above limit ... –; Below limit ... 1}

Appendix 4.

HANDSWORTH URBAN DISTRICT.—HOLLINSEND, INTAKE, AND GLEADLEY SEWAGE WORKS.

(District No. 8.)

Date completed and brought into operation	At the end of 1896.
Engineer	W. H. Lancashire, C.E., Sheffield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 2,800.
Average daily flow of sewage in dry weather	33,840 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Only yards and roofs.
Number of water closets in area drained	Three.
LAND.	
Total area	4 acres.
Whether underdrained, and how?	Subsoil drains with sanitary pipes.
Nett area upon which sewage can be treated	3 acres 1 rood 20 perches.
TANKS.	
Number and total capacity	Six. Capacity 40,000 gallons.
Used all together, or in series	In series of three.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	Rather more than 1 cwt. per diem.
How added	In chamber at tank head.
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£781 16 0
Laying out of land	£315 16 11
Tanks	£320 5 6
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			80 tons per annum.
How dealt with			Given away.
Cost, or			Wheeling out.
Return			None.
PRODUCE.			
Crops			Rape, oats, cabbages, and cauliflowers.
Value			£20 per annum.
WORKING EXPENSES.			
Labour			£70 per annum.
Chemicals			£45 per annum
Pumping			

Reports of Inspectors { Satisfactory ... 14; Unsatisfactory ... 7

Analyses { Above limit ... –; Below limit ...

Appendix 4.

HANDSWORTH URBAN DISTRICT.—RICHMOND AND BRITTON HILL SEWAGE WORKS.

(District No. 7.)

Date completed and brought into operation	At the end of 1896.
Engineer	W. H. Lancashire, C.E., Sheffield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 220.
Average daily flow of sewage in dry weather	2,640 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic (surface water excluded).
Number of water closets in area drained	Five.
LAND.	
Total area	One acre.
Whether underdrained, and how?	Subsoil drains.
Nett area upon which sewage can be treated	0 acres 3 roods 20 perches.
	NOTE.—A further area of 0 acres 3 roods 25 perches has been recently purchased.
TANKS.	
Number and total capacity	Two. Capacity 16,800 gallons.
Used all together, or in series	Together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	Small.
How added	In outfall pipe.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	1st lot £202 17 6. 2nd lot £246 5 0.
Laying out of land	£42 15 4.
Tanks	£109 16 3.
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			Nil.
Value			
WORKING EXPENSES.			
Labour			£39 per annum.
Chemicals			£5 per annum.
Pumping			

Reports of Inspectors { Satisfactory ... 8; Unsatisfactory ... 2 }

Analyses { Above limit ... ; Below limit ... – }

Appendix 4.

HANDSWORTH URBAN DISTRICT.—HANDSWORTH SEWAGE WORKS.
(District No. 5.)

Date completed and brought into operation	At the end of 1896.
Engineer	W. H. Lancashire, C.E., Sheffield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 1,175.
Average daily flow of sewage in dry weather	14,100 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Very small proportion.
Number of water closets in area drained	Seven.
LAND.	
Total area	2 acres.
Whether underdrained, and how?	Subsoil drain with sanitary pipes.
Nett area upon which sewage can be treated	2 acres.
TANKS.	
Number and total capacity	Two. Capacity 16,000 gallons.
Used all together, or in series	Together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	Half cwt. per diem.
How added	In chamber at tank head.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£504 5 8
Laying out of land	£197 18 7
Tanks	£91 9 8
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			Cauliflowers
Value			Nil, to present time.
WORKING EXPENSES.			
Labour			£52 per annum.
Chemicals			£23 per annum.
Pumping			

Reports of Inspectors { Satisfactory ... 13; Unsatisfactory ... 4 }

Analyses { Above limit ... –; Below limit ... 1 }

Appendix 4.

HAWORTH URBAN DISTRICT.—LEES AND CROSS ROADS SEWAGE WORKS.

Date completed and brought into operation	March, 1891.		
Engineer	A. E. Preston, C.E., Bradford.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	472 houses drained.		
Average daily flow of sewage in dry weather	52,074 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.		
Number of water closets in area drained	56.		
LAND.			
Total area	Nine acres.		
Whether underdrained, and how?	Underdrained by 6 inch loose socket pipes.		
Nett area upon which sewage can be treated	4½ acres.		
TANKS.			
Number and total capacity	Six tanks, 10,122 gallons.		
Used all together, or in series	Used in series.		
Whether flow of sewage continuous, or time allowed for settlement	Used both ways.		
CHEMICALS.			
Nature	None.		
Quantity	Do.		
How added	Do.		
FILTERS.			
Number and total area	Do.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Do.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.		
COST OF—			
Land	£2,270.		
Laying out of land	£1,175.		
Tanks			
Filters			
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount	Used on grass land.	Unable to state amount.	
How dealt with	Do.		
Cost, or	Do.		
Return	Do.		
PRODUCE.			
Crops	Let by tender. Tenant farms the land and takes produce. Rent £2 last year.		
Value	Do.		
WORKING EXPENSES.			
Labour	None.		
Chemicals	Do.		
Pumping	Do.		

Reports of Inspectors: Satisfactory ... 6; Unsatisfactory ... –

Analyses: Above limit ... ; Below limit ...

Appendix 4.

HECKMONDWIKE URBAN DISTRICT.—HECKMONDWIKE SEWAGE WORKS.

(Farm situate in the Borough of Dewsbury.)

Date completed and brought into operation	6th April 1896.
Engineer	James Saville, Town's Surveyor, Heckmondwike.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	697 acres. 2,384 houses. Population about 11,000.
Average daily flow of sewage in dry weather	Estimated to be 350,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mostly domestic. 1 large brewery and a few manufactories connected. Large portion of surface water included.
Number of water closets in area drained	About 630.
LAND.	
Total area	37½ acres, 31½ being available by gravitation.
Whether underdrained, and how?	15 inch to 9 inch main effluent full length of sand. 9 inch and 6 inch under drains to beds, open joints, rubble stone 1 ft. above pipes, laid at depths 6 to 8 ft. below surface of beds.
Nett area upon which sewage can be treated	28½ acres.
TANKS.	
Number and total capacity	Three.
Used all together, or in series	All together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works Construction—whether fixed side weirs, leaping weirs, or adjustable valves Proportion of flow in sewer to average flow when storm overflows begin to act	1 at the end of main outfall sewer to flow over when 21 inch pipes are half full. 1 on the line of main outfall sewer to flow over when 21 inch pipes are two-thirds full. Main outfall sewer 21 inch pipes are half full at outfall end when the pipes are fully charged at the Town end. Main outfall about 1½ miles long. Storm overflows in various sewers. Leaping weirs, set to throw when sewer runs more than in slight rains.
COST OF—	
Land	About £150 per acre.
Laying out of land	£3,200.
Tanks	£500.
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 6; Unsatisfactory 23

Analyses: Above limit 4; Below limit 4

Appendix 4.

HORBURY URBAN DISTRICT.—HORBURY SEWAGE WORKS.

Date completed and brought into operation	The sewage works were brought into operation on the 28th [December, 1895.
Engineer	Sam Shaw, Esq., Dewsbury.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	About 1,300 houses are drained.
Average daily flow of sewage in dry weather	Approximate average daily flow of sewage is 136,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic and trade sewage combined. Surface water is included.
Number of water closets in area drained	About 45 water-closets are drained into sewers.
LAND.	
Total area	17 acres 3 roods and 39 perches.
Whether underdrained, and how?	11 acres of above is underdrained by 18, 15, 12 and 9 inch pipes, also 4 inch tile drains.
Nett area upon which sewage can be treated	11 acres 2 roods and 27 perches.
TANKS.	
Number and total capacity	3 settling tanks. Total capacity 190,000 gallons.
Used all together, or in series	Used all together.
Whether flow of sewage continuous, or time allowed for settlement	Flow of sewage continuous.
CHEMICALS.	
Nature	No chemicals used at present.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	4 sludge filters, total area of same 678 square yards.
Construction	The sludge filters are constructed of 2 in. and 4 in. tile drain, and covered with filtering material to the depth of 2 ft. as follows:—12 in. broken bricks, 6 in. screened clinker ashes, and 6 in. fine ashes.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Used intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None on line of sewers. One at sewage works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	The level of weir is fixed at $\frac{2}{3}$ diameter of sewer.
COST OF—	
Land	11 acres 2 roods 27 perches now in use is leased from Horbury Common Land Trustees for 50 years at 50*l*. per annum, and 6 acres 1 rood and 12 perches not in use cost 1,250*l*.
Laying out of land	Cost 263*l*. 1*s*. 0*d*.
Tanks	The settling tanks cost 494*l*. 8*s*. 8*d*.
Filters	2 sludge filters in contract cost 61*l*. 12*s*. 0*d*., and 2 do. cost 101*l*. 6*s*. 2*d*. done by Council's men.

	1895.	1896.	1897.
SLUDGE.			
Amount	The average amount of sludge we obtain is 30 loads per week (dry)		
How dealt with	The sludge is given to farmers on condition they cart same away.		
Cost, or			
Return			
PRODUCE.			
Crops	The sewage farm is not cultivated.		
Value	Do.		
WORKING EXPENSES.			
Labour	The working expenses of the sewage farm are on an average 350*l*. per annum.		
Chemicals	Do.		
Pumping	Do.		

Reports of Inspectors: Satisfactory ... 21; Unsatisfactory 3

Analyses: Above limit ... 1; Below limit ... -

Appendix 4.

HOYLAND NETHER URBAN DISTRICT.—ELSECAR SEWAGE WORKS.

Date completed and brought into operation	January, 1897.
Engineer	William Farrington.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Area of District 2,084 acres.
Average daily flow of sewage in dry weather	Population 13,000.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water partly included.
Number of water closets in area drained	Not more than 12 water closets.
LAND.	
Total area	12 acres.
Whether underdrained, and how?	Yes. 6 inch pipes and 4 inch field tiles, about 4 feet deep.
Nett area upon which sewage can be treated	11 acres.
TANKS.	
Number and total capacity	Nine. 113,906 gallons.
Used all together, or in series	Both.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Spence's alumino-ferric.
Quantity	About 1 ton per month.
How added	In cage in mixing race.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Five.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	Sewer about ¾ full before overflows act.
COST OF—	
Land	£1,000.
Laying out of land	Total cost of works £2,830.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.	Have not details of cost.		
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 9; Unsatisfactory ... 8

Analyses: Above limit ...; Below limit ...

Appendix 4.

ILKLEY URBAN DISTRICT.—ILKLEY SEWAGE WORKS.

Date completed and brought into operation	November, 1898. (After extensions and alterations.)
Engineer	John Waugh, C.E., Bradford.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1,210 houses drained.
Average daily flow of sewage in dry weather	About 450,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. One laundry and one brewery. Surface water is included.
Number of water closets in area drained	1,255, and about 170 waste water closets.
LAND.	
Total area	Nine acres.
Whether underdrained, and how?	Earthenware subsoil drains.
Nett area upon which sewage can be treated	6⅓ acres.
TANKS.	
Number and total capacity	Five tanks. 170,000 gallons.
Used all together, or in series	May be used either way.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	150 lbs. per day.
How added	Automatic chemical mixer. (Pratt's patent.)
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Several on line of sewers and one at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Three fixed weirs and the rest adjustable valves.
Proportion of flow in sewer to average flow when storm overflows begin to act	Overflows at ¾ diameter of sewer.
COST OF—	
Land	The original scheme was carried out in 1876, and recent extensions have been carried out at a cost of £2,000, exclusive of value of land purchased under original scheme. No particulars easily available as to cost of original scheme, or how separated, except the total amount borrowed in 1876–7 was £15,000 for works of sewerage and sewage disposal.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Details already supplied to Inspector Tindall		
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 12; Unsatisfactory 6

Analyses { Above limit ... –; Below limit ... –

Appendix 4.

ILKLEY URBAN DISTRICT.—BEN RHYDDING SEWAGE WORKS.

Date completed and brought into operation	November, 1898.
Engineer	John Waugh, C.E., Bradford.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1,300 acres. 1,000 population.
Average daily flow of sewage in dry weather	Not been gauged yet.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water is excluded.
Number of water closets in area drained	255.
LAND.	
Total area	Eight and a half acres.
Whether underdrained, and how?	Subsoil drains under banks.
Nett area upon which sewage can be treated	Six acres.
TANKS.	
Number and total capacity	Tanks in duplicate. 30,000 gallons each.
Used all together, or in series	May be used either way.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	50 lbs. per day.
How added	By automatic chemical mixer.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One, on line of sewers.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	Overflows at $\frac{3}{4}$ diameter of sewer.
COST OF—	
Land	£1,300.
Laying out of land	£1,268.
Tanks	£480.
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	No details yet available. Works only completed in November last.		
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 10; Unsatisfactory ... 1

Analyses { Above limit ... -; Below limit ... -

Appendix

KNARESBOROUGH URBAN DISTRICT.—KNARESBOROUGH SEWAGE WORKS.

Date completed and brought into operation	1897. (Information not supplied by Authority.		
Engineer	D. Balfour, Newcastle.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	470 acres. 4,649 population (1891).		
Average daily flow of sewage in dry weather			
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade refuse (small volume). Yes.		
Number of water closets in area drained			
LAND.			
Total area	13 acres.		
Whether underdrained, and how?	5 acres underdrained.		
Nett area upon which sewage can be treated	10 acres.		
TANKS.			
Number and total capacity	Two tanks.		
Used all together, or in series	In series.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	None.		
Quantity	Do.		
How added	Do.		
FILTERS.			
Number and total area	Do.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works			
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weirs on sewers, adjustable weirs at sewage works.		
Proportion of flow in sewer to average flow when storm overflows begin to act			
COST OF—			
Land			
Laying out of land			
Tanks			
Filters			
	1895.	1896.	1897
SLUDGE.			
Amount			
How dealt with	Pumped on to sludge area, dried and carted away.		
Cost, or			
Return			
PRODUCE.			
Crops	Garden produce.	Garden produce.	Garden produce.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors {Satisfactory .. 17; Unsatisfactory

Analyses {Above limit ...; Below limit ...

Appendix 4.

METHLEY URBAN DISTRICT.—MICKLETOWN SEWAGE WORKS.

Date completed and brought into operation
Engineer
Whether sanctioned by L.G.B.
Area and population or number of houses drained
Average daily flow of sewage in dry weather
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?
Number of water closets in area drained

LAND.
Total area
Whether underdrained, and how?
Nett area upon which sewage can be treated

TANKS.
Number and total capacity
Used all together, or in series
Whether flow of sewage continuous, or time allowed for settlement

CHEMICALS.
Nature
Quantity
How added

FILTERS.
Number and total area
Construction
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method

STORM OVERFLOWS.
Number on line of sewers and at outfall works
Construction—whether fixed side weirs, leaping weirs, or adjustable valves
Proportion of flow in sewer to average flow when storm overflows begin to act

COST OF—
Land
Laying out of land
Tanks
Filters

Total cost £5,500. Cannot be divided.

	1895.	1896.	1897.
SLUDGE.			
Amount	No record.	No record.	No record.
How dealt with	Do.	Do.	Given away.
Cost, or	Do.	Do.	No record.
Return	Do.	Do.	None.
PRODUCE.			
Crops	Do.	Do.	Do.
Value	Do.	Do.	Do.
WORKING EXPENSES.			
Labour	Do.	Do.	No record.
Chemicals	Do.	Do.	None.
Pumping	Do.	Do.	Do.

Reports of Inspectors { Satisfactory ... — / Unsatisfactory 16

Analyses { Above limit – / Below limit –

Appendix 4.

METHLEY URBAN DISTRICT.—COMMON SIDE SEWAGE WORKS.

Date completed and brought into operation	1886.
Engineer	Messrs. Martin & Fenwick, Leeds.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	143 houses.
Average daily flow of sewage in dry weather	5,290 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Partially.
Number of water closets in area drained	None.
LAND.	
Total area	0 acres 3 roods 1 perch.
Whether underdrained, and how?	Yes.
Nett area upon which sewage can be treated	0 acres 2 roods 0 perches.
TANKS.	
Number and total capacity	4. 4,000 cubic feet.
Used all together, or in series	Series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	See above.
Construction	Underdrained and levelled
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	Held under lease from.
Laying out of land	Total cost £5,500. Cannot be divided.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	No record.	No record.	No record.
How dealt with	Do.	Do.	Given away.
Cost, or	Do.	Do.	No record.
Return	Do.	Do.	None.
PRODUCE.			
Crops	Do.	Do.	Do.
Value	Do.	Do.	Do.
WORKING EXPENSES.			
Labour	Do.	Do.	No record
Chemicals	Do.	Do.	None.
Pumping	Do.	Do	Do.

Reports of Inspectors: Satisfactory ... 18; Unsatisfactory 1

Analyses: Above limit .. –; Below limit ... –

Appendix 4.

METHLEY URBAN DISTRICT.—PINDER GREEN SEWAGE WORKS.

Date completed and brought into operation	1886.
Engineer	Messrs. Martin & Fenwick, Leeds.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	7 houses.
Average daily flow of sewage in dry weather	259.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included ?	Domestic. Partially.
Number of water closets in area drained	None.
LAND.	
Total area	0 acres 2 poods 34 perches.
Whether underdrained, and how ?	Yes. Land drain pipes.
Nett area upon which sewage can be treated	0 acres 2 roods 0 perches.
TANKS.	
Number and total capacity	4. 1,800 cubic feet.
Used all together, or in series	Series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	See above.
Construction	Underdrained and levelled.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	Held under lease from
Laying out of land	Total cost £5,500. Cannot be divided.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	No record.	No record.	No record.
How dealt with	Do.	Do.	Given away.
Cost, or	Do.	Do.	No record.
Return	Do.	Do.	None.
PRODUCE.			
Crops	Do.	Do.	No record.
Value	Do.	Do.	Do.
WORKING EXPENSES.			
Labour	Do.	Do.	Do.
Chemicals	Do.	Do.	None.
Pumping	Do.	Do.	Do.

Reports of Inspectors { Satisfactory ... 3; Unsatisfactory .

Analyses { Above limit ... –; Below limit ... –

Appendix 4.

METHLEY URBAN DISTRICT.—SCHOLEY HILL SEWAGE WORKS.

Date completed and brought into operation	1886.		
Engineer	Messrs. Martin & Fenwick, Leeds.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	76 houses.		
Average daily flow of sewage in dry weather	2,812 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Partially.		
Number of water closets in area drained	10.		
LAND.			
Total area	0 acres 1 rood 35 perches.		
Whether underdrained, and how?	Yes. Land drain pipes.		
Nett area upon which sewage can be treated	0 acres 1 rood 0 perches.		
TANKS.			
Number and total capacity	4. 4,000 cubic feet..		
Used all together, or in series	Series.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	None.		
Quantity	Do.		
How added	Do.		
FILTERS.			
Number and total area	See above.		
Construction	Underdrained and levelled.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	None.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.		
COST OF—			
Land	Land held under lease from		
Laying out of land	Total cost £5,500. Cannot be divided.		
Tanks			
Filters			
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount	No record.	No record.	No record.
How dealt with	Do.	Do.	Given away.
Cost, or	Do.	Do.	No record.
Return	Do.	Do.	None.
PRODUCE.			
Crops	Do.	Do.	Do.
Value	Do.	Do.	Do.
WORKING EXPENSES.			
Labour	Do.	Do.	No record.
Chemicals	Do.	Do	None.
Pumping	Do.	Do.	Do.

Reports of Inspectors { Satisfactory ... 7 ; Unsatisfactory ... 7 } ... Analyses { Above limit ... ; Below limit ... }

Appendix 4.

MEXBOROUGH URBAN DISTRICT.—MEXBOROUGH SEWAGE WORKS.

Date completed and brought into operation	1887.
Engineer	Mr. G. White, A.M.I.C.E., Mexborough.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Area 1,293 acres. Population estimated 10,000.
Average daily flow of sewage in dry weather	80 to 90,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included ?	Domestic. Yes.
Number of water closets in area drained	About 50.
LAND.	
Total area	$3\frac{1}{2}$ acres.
Whether underdrained, and how ?	Underdrained.
Nett area upon which sewage can be treated	$3\frac{1}{4}$ acres.
TANKS.	
Number and total capacity	Nine. 257,236 gallons (deduct 20,000 gallons, one tank used as a bacteriological filter).
Used all together, or in series	Series of 3.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement.
CHEMICALS.	
Nature	Alumino-ferric, originally black ash.
Quantity	About 6 to 8 grains to the gallon.
How added	Cakes placed in main sewage channel.
FILTERS.	
Number and total area	One of the above tanks 20 feet 0 inch × 22 feet 6 inch, 450 superficial feet turned into filter.
Construction	7 feet 6 inches deep coke breeze, aerated by ventilating pipes.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Dibdin's, continuous.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Three on line of sewers.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	12 inch pipe overflows, two on 18 inch main, one on 15 inch main.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895–6.	1896–7.	1897–8.
SLUDGE.			
Amount	No record kept, sludge run into lagoons to dry and then used as tillage on the sewage farm.		
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Mangolds, lints, rye grass.	Do.	(Mangolds staple crop.)
Value	£25 14 3	£34 17 1	Not made up until Dec. 31.
WORKING EXPENSES.			
Labour	£24 3 8	£35 1 6	Do.
Chemicals	£23 0 0	£22 3 10	Do.
Pumping	Labour £78 0 0 Coal £71 12 7	£78 0 0 £69 15 1	Do. Do.

Reports of Inspectors: Satisfactory ... 8; Unsatisfactory ... 3

Analyses: Above limit ... –; Below limit ... –

NORTH BIERLEY URBAN DISTRICT.—NORTH BIERLEY SEWAGE WORKS. Appendix 4.

Date completed and brought into operation	1880.		
Engineer	John Cook.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	4,308 acres. 22,753 population, or 5,890 houses drained.		
Average daily flow of sewage in dry weather	1,000,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, mixed with trade refuse. Surface water included.		
Number of water closets in area drained	285.		
LAND.			
Total area	18 acres.		
Whether underdrained, and how?	2 acres underdrained, 2 acres pit hill shale levelled 5 feet deep and soiled and undrained, and 6 acres buildings and sludge beds.		
Nett area upon which sewage can be treated	10 acres upon which sewage can be treated.		
TANKS.			
Number and total capacity	18 tanks. 200,000 gallons.		
Used all together, or in series	Used all together.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.		
CHEMICALS.			
Nature	Lime and alumino-ferric.		
Quantity	80 tons of alumino-ferric and 160 tons of lime per year.		
How added	Lime added as milk of lime, alumino-ferric in cakes.		
FILTERS.			
Number and total area	None. Effluent from tanks run on to land, except a recently levelled shale hill now acts as a filter.		
Construction			
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method			
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	3 on line of sewers and one at outfall works.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	3 on line of sewers side weirs, and at outfall works leaping weir.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Acts when ¾ full.		
COST OF—			
Land	(And Easement) £5,258 18s. 0d.		
Laying out of land	About £300.		
Tanks	(And Buildings) £3,192 19s. 5d.		
Filters			
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount	About 4,000 cubic yards yearly.		
How dealt with	Wet sludge run on to drained sludge beds, and allowed to dry, when dry carted away on to agricultural land &c., by farmers, at a cost of £100 a year.		
Cost, or			
Return			
PRODUCE.			
Crops	Grass and after grass.		
Value	About £20.		
WORKING EXPENSES.			
Labour	£210.	£210	£220
Chemicals	£210 alumino-ferric, £112 lime per year.		
Pumping	None.	None.	None.

Reports of Inspectors {Satisfactory ... 2; Unsatisfactory ... 30}

Analyses {Above limit ... –; Below limit ... 1}

Appendix 4.

OAKWORTH URBAN DISTRICT.—OAKWORTH SEWAGE WORKS.

Date completed and brought into operation	June, 1892.		
Engineer	B. Hopkinson & Co., Keighley.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	500 houses drained.		
Average daily flow of sewage in dry weather	318,744 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage. Surface water excluded as much as possible.		
Number of water closets in area drained	190.		
LAND.			
Total area	5 acres.		
Whether underdrained, and how?	Underdrained by 6 inch pipes.		
Nett area upon which sewage can be treated	5 acres, only 2½ used at present.		
TANKS.			
Number and total capacity	Two tanks. Capacity 26,562 gallons.		
Used all together, or in series	In series.		
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement.		
CHEMICALS.			
Nature			
Quantity			
How added			
FILTERS.			
Number and total area			
Construction			
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method			
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	None on line of sewers, one at outfall works.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Adjustable valves.		
Proportion of flow in sewer to average flow when storm overflows begin to act			
COST OF—			
Land	£934.		
Laying out of land	Approximately £1,300.		
Tanks			
Filters	None.		
	1895–6.	1896–7.	1897–8.
SLUDGE.			
Amount	What amount is accumulated is dealt with on the land.		
How dealt with	Do.		
Cost, or			
Return			
PRODUCE.			
Crops	Vegetables.	Vegetables.	Vegetables.
Value	44*l*. 10*s*. 11*d*.	54*l*. 5*s*. 0*d*.	44*l*. 3*s*. 6*d*.
WORKING EXPENSES.			
Labour	59*l*. 10*s*. 3*d*.	54*l*. 13*s*. 8*d*.	55*l*. 4*s*. 7*d*.
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 36; Unsatisfactory 3

Analyses: Above limit ... 2; Below limit ... –

Appendix 4.

OSSETT BOROUGH URBAN DISTRICT.—OSSETT (SPA OUTFALL) SEWAGE WORKS.

Date completed and brought into operation	
Engineer	Malcolm Paterson.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	300,000 per 12 hours.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, trade refuse, and storm water.
Number of water closets in area drained	
LAND.	
Total area	22 acres.
Whether underdrained, and how?	Underdrained
Nett area upon which sewage can be treated	7 acres.
TANKS.	
Number and total capacity	Three sets of tanks. Capacity 270,000.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Milk of lime and alumino-ferric
Quantity	
How added	
FILTERS.	
Number and total area	No filters.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	4 on line of sewer, 1 at sewage works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	Average 1,200 cubic yards per annum.		
How dealt with	We pay 1s. per load for carting on land.		
Cost, or			
Return			
PRODUCE.			
Crops	Nil.		
Value	D .		
WORKING EXPENSES.			
Labour	£190 per annum.		
Chemicals	65.		
Pumping			

Reports of Inspectors { Satisfactory ... 2; Unsatisfactory 18

Analyses { Above limit ... ; Below limit 2

Appendix 4.

OSSETT BOROUGH URBAN DISTRICT.—HEALEY SEWAGE WORKS.

Date completed and brought into operation			
Engineer	Malcolm Paterson.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained			
Average daily flow of sewage in dry weather	65,000 gallons per 12 hours.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, trade refuse, and storm water.		
Number of water closets in area drained			
LAND.			
Total area	About $1\frac{1}{2}$ acres.		
Whether underdrained, and how?	Underdrained.		
Nett area upon which sewage can be treated	$1\frac{1}{2}$ acres.		
TANKS.			
Number and total capacity	Three tanks. 50,000 gallons.		
Used all together, or in series			
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	Milk of lime and alumino-ferric blocks.		
Quantity			
How added	Lime, water-wheel.		
FILTERS.			
Number and total area	No filters.		
Construction			
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method			
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	One at sewage works.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weir.		
Proportion of flow in sewer to average flow when storm overflows begin to act			
COST OF—			
Land			
Laying out of land			
Tanks			
Filters			
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount	Average 360 cubic yards per annum.		
How dealt with	We pay 1s. per load carting on land.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	£62 per annum.		
Chemicals	£24 per annum.		
Pumping			

Reports of Inspectors {Satisfactory ... 8; Unsatisfactory ... 8}

Analyses {Above limit ... –; Below limit ... –}

Appendix 4

OTLEY URBAN DISTRICT.—OTLEY SEWAGE WORKS.

Date completed and brought into operation	1893.		
Engineer	Messrs. Brierley & Holt, Blackburn.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	1,800 houses. Population 8,400.		
Average daily flow of sewage in dry weather	180,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed, domestic and trade, mixed. Yes.		
Number of water closets in area drained	300.		
LAND.			
Total area	8 acres.		
Whether underdrained, and how?	Yes. Tiles 6 inches apart.		
Nett area upon which sewage can be treated	5 acres.		
TANKS.			
Number and total capacity	4. 160,000 gallons.		
Used all together, or in series	Intermittently used in series		
Whether flow of sewage continuous, or time allowed for settlement	Time allowed.		
CHEMICALS.			
Nature	Alumino-ferric.		
Quantity	½ cwt. per day.		
How added	Placed in cuffling wire		
FILTERS.			
Number and total area	None.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works			
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weirs.		
Proportion of flow in sewer to average flow when storm overflows begin to act			
COST OF—			
Land	£1,800.		
Laying out of land	£8,000.		
Tanks			
Filters			
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount			
How dealt with	Given away.	Given away.	Given away.
Cost, or			
Return			
PRODUCE.			
Crops	Turnips, cabbages, peas, beans and carrots.	Turnips, cabbages, peas, beans and carrots.	Turnips, cabbages, peas, beans, and carrots.
Value	£25		
WORKING EXPENSES.			
Labour	£120		
Chemicals	£60		
Pumping			

Reports of Inspectors: Satisfactory ... 1; Unsatisfactory ... 26

Analyses: Above limit ... -; Below limit ... 5

Appendix 4.

OXENHOPE URBAN DISTRICT.—OXENHOPE SEWAGE WORKS.

Date completed and brought into operation	November, 1897.
Engineer	Barber Hopkinson & Co., Keighley.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	240 houses drained.
Average daily flow of sewage in dry weather	15,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. No road water, but eaves water where tipper closets are used.
Number of water closets in area drained	55.
LAND.	
Total area	11 acres 2 roods 38 perches.
Whether underdrained, and how?	Not underdrained.
Nett area upon which sewage can be treated	7 acres 2 roods 0 perches.
TANKS.	
Number and total capacity	One. 15,000 gallons.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	Two in use, and two in course of construction. The total area is 398 square yards.
Construction	Broken stone and coke breeze.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. Dibdin's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£1,650.
Laying out of land	Nil.
Tanks	£180.
Filters	£460.

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 9; Unsatisfactory 9 }

Analyses { Above limit ... –; Below limit .. 1 }

Appendix 4.

QUEENSBURY URBAN DISTRICT.—QUEENSBURY SEWAGE WORKS.

Date completed and brought into operation	1895. (Information not supplied by Authority.)
Engineer	John Drake.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	6,740 population. 1,471 acres.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade refuse. Yes.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	3 acres of land. I.D.F.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	Eleven tanks.
Used all together, or in series	All together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	
How added	Put into channel
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Several on line of sewers. One at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Put on to sludge filters.	Some carted away.	
Cost, or			
Return			
PRODUCE.			
Crops	Vegetables.	Vegetables.	Vegetables.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 4; Unsatisfactory 22

Analyses: Above limit ... 1; Below limit ... -

Appendix 4.

RAVENSTHORPE URBAN DISTRICT.—RAVENSTHORPE SEWAGE WORKS.

Date completed and brought into operation	1876.
Engineer	Malcolm Paterson, C.E.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	375 acres. Population 5,500. No. of houses 1,350.
Average daily flow of sewage in dry weather	160,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	100.
LAND.	
Total area	14 acres.
Whether underdrained, and how?	Partially. Pipes.
Nett area upon which sewage can be treated	6 acres 3 roods 23 perches.
TANKS.	
Number and total capacity	Three. Capacity 38,250 gallons.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous when pumping.
CHEMICALS.	
Nature	Lime as milk of lime.
Quantity	36 tons per annum.
How added	By lime mixer to carrier.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One on sewer.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weir.
Proportion of flow in sewer to average flow when storm overflows begin to act	When tank sewer overflows.
COST OF—	
Land	£15,000.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Buried.	Buried.	Buried.
Cost, or			
Return			
PRODUCE.			
Crops	Oats.	Oats.	Oats.
Value	£5 0 0	£5 0 0	£5 0 0
WORKING EXPENSES.			
Labour	£200 0 0	£200 0 0	£200 0 0
Chemicals	£30 0 0	£30 0 0	£30 0 0
Pumping	£112 16 0	£112 16 0	£112 16 0

Reports of Inspectors { Satisfactory ... ; Unsatisfactory 6 }

Analyses { Above limit ... 1 ; Below limit ... 1 }

Appendix 4.

RAWDON URBAN DISTRICT.—RAWDON SEWAGE WORKS.

Date completed and brought into operation	1897.
Engineer	William Henry Radford, Nottingham.
Whether sanctioned by L.G.B.	The plans and scheme were sanctioned by L.G.B.
Area and population or number of houses drained	14,059 acres. Population 3,077.
Average daily flow of sewage in dry weather	About 50,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Almost entirely domestic. Excluded as much as possible.
Number of water closets in area drained	Not known exactly.
LAND.	
Total area	15 acres.
Whether underdrained, and how?	Drained with land tiles. Drains 5 feet deep, 7 yards apart.
Nett area upon which sewage can be treated	12 acres.
TANKS.	
Number and total capacity	6 tanks each 20 × 20 feet × 6 feet deep.
Used all together, or in series	Used in two sets of 3 each.
Whether flow of sewage continuous, or time allowed for settlement	A continuous flow through one set of tanks until there is a fair amount of deposit, when they are drawn off and the other set put in use.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	About 10 to 12 grains to a gallon.
How added	It is dissolved in a large tub, from which a continuous stream is sprinkled into the sewage as it leaves the outfall pipe.
FILTERS.	
Number and total area	After chemical precipitation the sewage flows on the land for filtration.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	2 fixed in manholes.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	A 12-inch pipe is filled to a depth of 10 inches before it flows over the storm weir.
COST OF—	
Land	£4,446.
Laying out of land Tanks Filters	Mixed up with other items in contract. Over £18,000 have been expended on the scheme already, and various extensions are now required.

	1895.	1896.	1897.
SLUDGE.			
Amount How dealt with Cost, or Return	We have an excellent lime mixing machine, but as we do not need to use lime at present, we have very little sludge, and the little we have can be dealt with on our own land for years to come, as the land is of a very sandy nature.		
PRODUCE.			
Crops	Turnips, potatoes, cabbages, &c.		
Value			
WORKING EXPENSES.			
Labour	For treatment not separated from other costs in connection [with sewag		
Chemicals	18 to 20 pounds.		
Pumping	None.		

Reports of Inspectors { Satisfactory ... 4
Unsatisfactory ... –

Analyses { Above limit ...
Below limit ..

Appendix 4.

ROTHWELL URBAN DISTRICT.—LEMONROYD SEWAGE WORKS.

Date completed and brought into operation	July, 1898.
Engineer	Sam Shaw, Dewsbury.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1,708 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade refuse. Partly.
Number of water closets in area drained	
LAND.	
Total area	20 acres.
Whether underdrained, and how?	Yes. 4 inch pipes.
Nett area upon which sewage can be treated	18 acres.
TANKS.	
Number and total capacity	9. 26,000 gallons.
Used all together, or in series	In series of 3.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	Alumino-ferric and lime.
Quantity	½ ton alumino-ferric per week.
How added	Alumino-ferric in box of outfall channel, lime mixed with engine.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	1 on line of sewers and 1 at outfall.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Movable boards
Proportion of flow in sewer to average flow when storm overflows begin to act	Two-thirds.
COST OF—	
Land	£7,000.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1898 (6 months)
SLUDGE.			
Amount			230 loads.
How dealt with			Removed by farmers
Cost, or			None.
Return			Do.
PRODUCE.			
Crops			Do.
Value			Do.
WORKING EXPENSES.			
Labour			£91 5 0
Chemicals			£29 6 0
Pumping			None.

Reports of inspectors { Satisfactory ... 16; Unsatisfactory – }

Analyses { Above limit ... 1; Below limit ... – }

ROTHWELL URBAN DISTRICT.—THORPE SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	July, 1895.		
Engineer	T. H. & W. E. Richardson, Bond Street, Leeds.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	127 houses.		
Average daily flow of sewage in dry weather			
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Part.		
Number of water closets in area drained	None.		
LAND.			
Total area	1 acre 0 roods 20 perches.		
Whether underdrained, and how?	Yes. 4 inch pipes.		
Nett area upon which sewage can be treated	1 acre 0 roods 16 perches.		
TANKS.			
Number and total capacity	3. 4,400 gallons.		
Used all together, or in series	Used all together.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	Alumino-ferric.		
Quantity	About 2½ cwt. per week.		
How added	A block is put in carrier at outfall.		
FILTERS.			
Number and total area	None.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	One.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Adjustable valve.		
Proportion of flow in sewer to average flow when storm overflows begin to act			
COST OF—			
Land	£1 062.		
Laying out of land			
Tanks			
Filters			
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount			
How dealt with	Taken away by farmers.	Taken away by farmers.	Taken away by farmers.
Cost, or			
Return			
PRODUCE.			
Crops	Vegetables.	Vegetables.	Vegetables.
Value	The land is cropped by the attendant who receives the value (if any) in part payment of attendance.		
WORKING EXPENSES.			
Labour	£2 18 0	£7 16 0	£7 16 0
Chemicals	£11 4 7	£22 9 2 (Part used in 1897.)	£10 18 6
Pumping	None.	None.	None

Reports of Inspectors { Satisfactory ... 8; Unsatisfactory – }

Analyses { Above limit ... –; Below limit ... }

Appendix 4.

ROYSTONE URBAN DISTRICT.—CUDWORTH LANE SITE SEWAGE WORKS.

Date completed and brought into operation	1895.
Engineer	Joseph Latham, Barnsley.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	700 houses.
Average daily flow of sewage in dry weather	30,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included ?	Domestic only. To small extent.
Number of water closets in area drained	About 20.
LAND.	
Total area	7 acres 3 roods 6 perches.
Whether underdrained, and how ?	Underdrained.
Nett area upon which sewage can be treated	½ acres.
TANKS.	
Number and total capacity	None.
Used all together, or in series	Do.
Whether flow of sewage continuous, or time allowed for settlement	Do.
CHEMICALS.	
Nature	Do.
Quantity	Do.
How added	Do
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two at outlet works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£3,800 including sewerage.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	All dealt with on land and treated into same.		
How dealt with	Do.		
Cost, or	Do.		
Return	Do.		
PRODUCE.			
Crops	Let for £5 per annum.	Let for £5 per annum.	Nil.
Value			
WORKING EXPENSES.			
Labour			
Chemicals	Nil.	Nil.	£50 per annum.
Pumping			

Reports of Inspectors { Satisfactory ... 2; Unsatisfactory ... 13

Analyses { Above limit ... –; Below limit ... –

SILSDEN URBAN DISTRICT.—SILSDEN SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	Main works completed January, 1898.
Engineer	Chas. Gott, Bradford.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 4,000.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. No.
Number of water closets in area drained	300.
LAND.	
Total area	12 acres.
Whether underdrained, and how?	Underground, with 18 inch pipes, 6 feet deep.
Nett area upon which sewage can be treated	9 to 10 acres.
TANKS.	
Number and total capacity	No. 5. Capacity 8,500 gallons.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	3.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	Never required.
COST OF—	
Land	£1,713.
Laying out of land	Not yet completed.
Tanks	
Filters	None.

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 20; Unsatisfactory 22

Analyses { Above limit ... 1; Below limit ... 2

Appendix 4.

SOOTHILL NETHER URBAN DISTRICT.—SOOTHILL NETHER SEWAGE WORKS.

Date completed and brought into operation	1893.		
Engineer	Malcolm M. Paterson, C.E., Bradford.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	562 acres. Population about 5,900.		
Average daily flow of sewage in dry weather	150,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic and trade effluent. Surface water not included.		
Number of water closets in area drained	70.		
LAND.			
Total area	5 acres.		
Whether underdrained, and how?	Underdrained with 3 inch dry socketed pipes.		
Nett area upon which sewage can be treated	3½ acres.		
TANKS.			
Number and total capacity	Three. Total capacity 147,200 gallons.		
Used all together, or in series	Series.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	Alumino-ferric and lime.		
Quantity	2 tons in 3 months lime and alumino-ferric.		
How added	By lime mixer driven by flow of sewage and alumino-ferric put into channels.		
FILTERS.			
Number and total area	For drying sludge only.		
Construction			
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method			
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Seven.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weirs.		
Proportion of flow in sewer to average flow when storm overflows begin to act	About 6 times.		
COST OF—			
Land	£1,250.		
Laying out of land	Fences and road £800.		
Tanks	£440.		
Filters	£150.		
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount			
How dealt with	Dried and stored and	given away if anyone	will take it.
Cost, or			
Return	None.		
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	£96 2 8.	£163 1 6.	£136 16 0.
Chemicals	£9 5 0.	£15 14 0.	£33 11 3.
Pumping	No, gravitation.		

Reports of Inspectors: Satisfactory ... 4; Unsatisfactory ... 13

Analyses: Above limit ..; Below limit ... 1

Appendix 4.

SOUTHOWRAM URBAN DISTRICT.—CROMWELL WOOD SEWAGE WORKS.

Date completed and brought into operation	1876. (Information not supplied by Authority.		
Engineer			
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	240 houses.		
Average daily flow of sewage in dry weather			
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.		
Number of water closets in area drained			
LAND.			
Total area			
Whether underdrained, and how?			
Nett area upon which sewage can be treated			
TANKS.			
Number and total capacity	2 tanks.		
Used all together, or in series	Alternately.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	None.		
Quantity	Do.		
How added	Do.		
FILTERS.			
Number and total area	Do.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Do.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.		
COST OF—			
Land			
Laying out of land			
Tanks			
Filters			
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount			
How dealt with	Tipped on to surface of land.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... – ; Unsatisfactory 16

Analyses { Above limit ... – ; Below limit .. –

Appendix 4.

THORNHILL URBAN DISTRICT.—THORNHILL SEWAGE WORKS.

Date completed and brought into operation	April, 1894.		
Engineer	Sam. W. Parker.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	About 1,700 houses.		
Average daily flow of sewage in dry weather	About 200,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic only. Roofs only.		
Number of water closets in area drained	70 to 80.		
LAND.			
Total area	12 acres.		
Whether underdrained, and how?	Underdrained with 4 inch land tiles.		
Nett area upon which sewage can be treated	7 acres.		
TANKS.			
Number and total capacity	Two series of 7 tanks. Total capacity 325,000 gallons.		
Used all together, or in series	Used together, except when one set are being cleaned.		
Whether flow of sewage continuous, or time allowed for settlement	The sewage is pumped through the tanks in about 4 hours.		
CHEMICALS.			
Nature	Alumino-ferric and lime.		
Quantity	8 grains alumino-ferric. 2 grains lime (milk) per gallon.		
How added	Alumino-ferric blocks placed in chemical chamber, and sewage pumped on to it, the lime is made into milk of lime and mixed with sewage in the pump well.		
FILTERS.			
Number and total area	None.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	One on line of sewers, and one at outfall works.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Adjustable valves and penstock valve.		
Proportion of flow in sewer to average flow when storm overflows begin to act			
COST OF—			
Land	Leased from Savile Estate.		
Laying out of land			
Tanks			
Filters			
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount	No calculation.	No calculation.	No calculation.
How dealt with	Runs by gravitation to sludge bed, and after drying carted on to land by farmer.		
Cost, or			
Return	None.	None.	None.
PRODUCE.			
Crops	Filter beds let to farmer, last year's crop oats and mangels.		
Value			
WORKING EXPENSES.			
Labour			£130.
Chemicals			About £36
Pumping			

Reports of Inspectors { Satisfactory ... 5; Unsatisfactory – }

Analyses { Above limit ... –; Below limit ... – }

THURLSTONE URBAN DISTRICT.—THURLSTONE SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	Formally opened 22nd October, 1897.
Engineer	T. A. Murray, C.E. (Sheffield).
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Area about 1,000 acres. Population 2,000. Houses 300.
Average daily flow of sewage in dry weather	80,000 gallons per day.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed. Surface water excluded.
Number of water closets in area drained	About six.
LAND.	
Total area	7½ acres.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	6 acres divided into 14 plots.
TANKS.	
Number and total capacity	Two, holding 15,000 gallons.
Used all together, or in series	Together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric, but none used up to the present.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	None. The system being intermittent land filtration.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	During storms the outflow into settling tanks is increased by at least ¾ the normal average flow, and completely filling the pipes.
COST OF—	
Land	£923.
Laying out of land	£400.
Tanks	£276.
Filters	

	1895.	1896.	1898.
SLUDGE.			
Amount			4 cart loads per month.
How dealt with			Used on sewage farm plots for tillage purposes.
Cost, or			
Return			
PRODUCE.			
Crops	Oats, cabbages, cauliflowers, peas, celery, and other market garden produce.		
Value	Only 2 or 3 of the plots on the sewerage farm have, during 1898, been cultivated. When the whole of the land is utilized, it is expected to produce what will cover working expenses.		
WORKING EXPENSES.			
Labour			£100 per year (estimated).
Chemicals			Nil.
Pumping			Nil.

Reports of Inspectors { Satisfactory ... 5; Unsatisfactory ... 1 }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

TICKHILL URBAN DISTRICT.—TICKHILL SEWAGE WORKS.

Date completed and brought into operation	October, 1896.		
Engineer	T. Aird Murray.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	337 houses.		
Average daily flow of sewage in dry weather			
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.		
Number of water closets in area drained	14.		
LAND.			
Total area	4 acres 2 roods 18 perches.		
Whether underdrained, and how?	Underdrained.		
Nett area upon which sewage can be treated	4 acres.		
TANKS.			
Number and total capacity	2. 972 cubic feet. 1 flushing tank, 4,000 gallons.		
Used all together, or in series	Series.		
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement.		
CHEMICALS.			
Nature	Carbolic acid.		
Quantity			
How added			
FILTERS.			
Number and total area	None.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	1 on line of sewer.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side sewers.		
Proportion of flow in sewer to average flow when storm overflows begin to act			
COST OF—			
Land	£345 18 9.		
Laying out of land	£197 15 11.		
Tanks	£143 14 0.		
Filters			
	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			Land let to allotment holders.
Value			Gross rents £3 14*s.* 10*d.*
WORKING EXPENSES.			
Labour			£23 8 0.
Chemicals			£5 0 0.
Pumping			

Reports of Inspectors { Satisfactory ... 11; Unsatisfactory ... 2

Analyses { Above limit ... –; Below limit ... –

Appendix 4.

WHITLEY UPPER URBAN DISTRICT.—GRANGE LANE SEWAGE WORKS.

Date completed and brought into operation	About January, 1898.
Engineer	R. W. Young, Middlestown.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	About 2 acres. Population about 65.
Average daily flow of sewage in dry weather	Say 65 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Solely domestic.
Number of water closets in area drained	None.
LAND.	
Total area	One line of sewer and site of tank.
Whether underdrained, and how?	Do.
Nett area upon which sewage can be treated	Do.
TANKS.	
Number and total capacity	8 × 6 × 5 feet.
Used all together, or in series	All together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	10s.
Laying out of land	Nil.
Tanks	About £10.
Filters	Nil.

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.	Not applicable, but working expenses up to present, nil		
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 5; Unsatisfactory . –

Analyses: Above limit .. ; Below limit .

Appendix 4.

WHITWOOD URBAN DISTRICT.—HIGHTOWN SEWAGE WORKS.

Date completed and brought into operation	September, 1882.		
Engineer	John Richardson, Esq., C.E.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	Area 1,082 acres. Last census 4,806 (present estimate 5,500).		
Average daily flow of sewage in dry weather	About 100,000 estimated.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Partly.		
Number of water closets in area drained	12.		
LAND.			
Total area	49 acres 2 roods.		
Whether underdrained, and how?	Partly.		
Nett area upon which sewage can be treated	36 acres.		
TANKS.			
Number and total capacity	Mere pumping station—2 tanks = 400,000. Cutsyke farm—7 tanks. Whitwood—2 tanks.		
Used all together, or in series	Mere pumping station—altogether. Cutsyke farm—altogether Whitwood—altogether.		
Whether flow of sewage continuous, or time allowed for settlement	Mere pumping station—time allowed for settlement. Cutsyke farm—continuous. Whitwood—continuous.		
CHEMICALS.			
Nature			
Quantity			
How added			
FILTERS.			
Number and total area			
Construction			
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method			
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	1 at outfall at Cutsyke.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Slide.		
Proportion of flow in sewer to average flow when storm overflows begin to act			
COST OF—			
Land	Sewage land is on lease.		
Laying out of land	The whole scheme cost over £14,946.		
Tanks			
Filters			
	1895.	1896.	1897.
SLUDGE.			
Amount	No account kept.	No account kept.	No account kept.
How dealt with	Spread on land for manure.	Spread on land for manure.	Spread on land for manure.
Cost, or	No account kept.	No account kept.	No account kept.
Return			
PRODUCE.			
Crops	Grass and vegetables.	Grass and vegetables.	Grass and vegetables.
Value	£83 17 8.	£124 10 10.	£108 5 4.
WORKING EXPENSES.			
Labour	£155 16 4.	£96 12 5.	£218 18 6.
Chemicals			
Pumping	£78 0 0.	£83 4 0.	£87 12 0.

Reports of Inspectors: Satisfactory ... 9; Unsatisfactory 7

Analyses: Above limit ... –; Below limit ... –

DONCASTER RURAL DISTRICT.—CUSWORTH, SPROTBOROUGH SEWAGE WORKS. Appendix 4.

Date completed and brought into operation	1892.
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	3 acres.
Average daily flow of sewage in dry weather	200 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	6
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	Two.
Used all together, or in series	Used separately.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	About £600. Private work.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 2; Unsatisfactory }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

HEMSWORTH RURAL DISTRICT.—ACKWORTH SEWAGE WORKS.

Date completed and brought into operation	July, 1898.
Engineer	T. H. Richardson.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Back yards and roofs admitted.
Number of water closets in area drained	From 40 to 50.
LAND.	
Total area	5 acres 1 rood 26 perches.
Whether underdrained, and how?	Yes. 4 inch unsocketed pipes.
Nett area upon which sewage can be treated	4 acres 3 roods.
TANKS.	
Number and total capacity	Three tanks. Two 16 ft. 0 inch × 17 ft. 0 inch, and one 18 ft. 0 inch × 7 ft. 0 inch. Each 3 ft. deep.
Used all together, or in series	Used in series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	Amount not known, as site not been in work for any length of time.
How added	In block in channel.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two in line of sewers, one inoperative.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	7 times.
COST OF—	
Land	(And easements) 750*l*.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Given away.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			
WORKING EXPENSES.			
Labour	£40 per annum.		
Chemicals	Not known at present.		
Pumping	None.		

Reports of Inspectors { Satisfactory ... 9; Unsatisfactory 5

Analyses { Above limit ... -; Below limit ... 1

Appendix 4.

HEMSWORTH RURAL DISTRICT.—HEMSWORTH SEWAGE WORKS.

Date completed and brought into operation	Autumn, 1896.
Engineer	T. H. Richardson.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Back yards, roofs, and portion of road water admitted.
Number of water closets in area drained	About 25.
LAND.	
Total area	4 acres.
Whether underdrained, and how?	Yes. 4-inch unsocketted pipes.
Nett area upon which sewage can be treated	About 3 acres.
TANKS.	
Number and total capacity	6 tanks. Two 16 feet 0 inch × 15 feet 0 inch, two 15 feet 0 inch × 14 feet 0 inch, and two 15 feet 0 inch × 12 feet 0 inch. Average 3 feet deep.
Used all together, or in series	Used in series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	4 cwt. per week.
How added	In block in channel.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	2 on line of sewers, one 7 inch above invert. Both fixed weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	About 5 times.
COST OF—	
Land	(And easements) £1,050.
Laying out of land	All in one contract.
Tanks	All in one contract.
Filters	All in one contract.

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Given away.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			
WORKING EXPENSES.			
Labour	£50 per year, including Kinsley.		
Chemicals	£26 per year		
Pumping	None.		

Reports of Inspectors: Satisfactory ... 1; Unsatisfactory ... 16

Analyses: Above limit ... 1; Below limit ...

Appendix 4.

HEMSWORTH RURAL DISTRICT.—KINSLEY SEWAGE WORKS.

Date completed and brought into operation	Summer, 1896.
Engineer	T. H. Richardson.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Water from back yards and roofs admitted.
Number of water closets in area drained	One.
LAND.	
Total area	2 acres 1 rood 0 perches.
Whether underdrained, and how?	Yes. 4-inch unsocketted pipes.
Nett area upon which sewage can be treated	2 acres 1 rood 0 perches.
TANKS.	
Number and total capacity	2 tanks. 14 feet 0 inch × 14 feet 0 inch, and 14 feet 0 inch × 12 feet 0 inch. Each 3 feet deep.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	2 cwt. per week.
How added	In block in channel.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	Lease for 21 years at £12 10s. 0d. per annum.
Laying out of land	Let in one contract.
Tanks	Let in one contract.
Filters	Let in one contract.

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Given away.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			
WORKING EXPENSES.			
Labour	£50 per annum including Hemsworth.		
Chemicals	£13 per annum.		
Pumping	None.		

Reports of Inspectors: Satisfactory ... 5; Unsatisfactory ... 13

Analyses: Above limit ... -; Below limit ... 1

Appendix 4

HEMSWORTH RURAL DISTRICT.—GREAT HOUGHTON SEWAGE WORKS.

Date completed and brought into operation	Autumn, 1894.
Engineer	T. H. Richardson.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Water from back yards and roofs admitted.
Number of water closets in area drained	None.
LAND.	
Total area	2 acres 0 roods 14 perches.
Whether underdrained, and how?	Yes. 4-inch unsocketted pipes.
Nett area upon which sewage can be treated	1 acre 2 roods 0 perches.
TANKS.	
Number and total capacity	Two tanks. One 16 feet 0 inch × 16 feet 0 inch, and one 14 feet 0 inch × 12 feet 0 inch. 3 eet deep.
Used all together, or in series	Used in series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	2 cwts. per week .
How added	In block in channel
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	for 21 years at £8 7s. 0d. per annum.
Laying out of land	All let in one contract.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Given away.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			
WORKING EXPENSES.			
Labour	Let by contract.		
Chemicals	£13 per annum		
Pumping	None.		

Reports of Inspectors. Satisfactory ... 8; Unsatisfactory ... 4

Analyses: Above limit ... 1; Below limit ... -

Appendix 4.

HEMSWORTH RURAL DISTRICT.—SANDHILL SEWAGE WORKS.

Date completed and brought into operation	Autumn, 1894.
Engineer	T. H. Richardson.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Roof and back yard water admitted.
Number of water closets in area drained	None.
LAND.	
Total area	2 acres 3 roods 0 perches, and 0 acres 2 roods 0 perches.
Whether underdrained, and how?	Yes. 4-inch unsocketted pipes.
Nett area upon which sewage can be treated	1½ roods.
TANKS.	
Number and total capacity	2 tanks. Each 14 feet 0 inches × 12 feet 0 inch, and 3 feet deep.
Used all together, or in series	Worked in series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	Lease for 21 years at £2 10*s*. 0*d*., £2 11*s*. 6*d*. er annum.
Laying out of land	Let in one contract.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Given away.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			
WORKING EXPENSES.			
Labour	Let by contract.		
Chemicals	None.		
Pumping	Do.		

Reports of Inspectors { Satisfactory ... 7; Unsatisfactory . 2 }

Analyses { Above limit ... –; Below limit ... 1 }

HEMSWORTH RURAL DISTRICT.—STATION OUTFALL, RYHILL, SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	Summer, 1896.
Engineer	T. H. Richardson.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only.
Number of water closets in area drained	None.
LAND.	
Total area	1½ acres.
Whether underdrained, and how?	Yes. 4-inch unsocketted pipes.
Nett area upon which sewage can be treated	1 acre.
TANKS.	
Number and total capacity	2 tanks. Each 47 feet 0 inch × 16 feet 0 inch, and 3 feet deep.
Used all together, or in series	Used alternately.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement variable.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	About 4 cwts. per week.
How added	In block in channel.
FILTERS.	
Number and total area	2 filters. Each 24 feet 0 inch × 27 feet 0 inch, and 18 inches deep.
Construction	Coke breeze and sand.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Occasionally held up in the filters before distribution on to sand.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£170 for 1 acre, and £91 for ½ acre and easements.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Given away.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			
WORKING EXPENSES.			
Labour	£6 15s. 0d. per quarter, including Brunswick site.		
Chemicals	£26 per annum.		
Pumping	None.		

Reports of Inspectors { Satisfactory ... 7; Unsatisfactory 10 }

Analyses { Above limit ... 1; Below limit ... – }

Appendix 4.

HEMSWORTH RURAL DISTRICT.—BRUNSWICK OUTFALL, RYHILL, SEWAGE WORKS.

Date completed and brought into operation	
Engineer	T. H. Richardson.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only.
Number of water closets in area drained	None.
LAND.	
Total area	640 square yards.
Whether underdrained, and how?	Underdrained by 4-inch unsocketted pipes.
Nett area upon which sewage can be treated	About 20 perches.
TANKS.	
Number and total capacity	2 tanks. Each 10 feet 0 inch × 10 feet 0 inch, and 3 feet deep.
Used all together, or in series	Used alternately.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£62 0s. 0d.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Paid for carting away.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			
WORKING EXPENSES.			
Labour	£6 15s. 0d. per quarter including station outfall site.		
Chemicals	None.		
Pumping	Do.		

Reports of Inspectors { Satisfactory ... 2; Unsatisfactory - }

Analyses { Above limit ... 1; Below limit ... - }

HEMSWORTH RURAL DISTRICT.—SOUTH HIENDLEY SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	Autumn, 1894.
Engineer	T. H. Richardson.
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Back yards and roofs admitted.
Number of water closets in area drained	Two.
LAND.	
Total area	2 acres 3 roods 23 perches.
Whether underdrained, and how?	Yes. 4-inch unsocketted pipes.
Nett area upon which sewage can be treated	2 acres.
TANKS.	
Number and total capacity	2 tanks. One 16 feet 0 inch × 14 feet 0 inch, and one 14 feet 0 inch × 12 feet 0 inch. Each 3 feet deep.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	About 2 cwts. per week.
How added	When necessary in blocks in channel.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£290.
Laying out of land	Sewers and outfall site let in one contract.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Sludge given away.		
Cost, or			
Return			
PRODUCE.			
Crops	The caretaker has the benefit of crops in consideration for management.		
Value			
WORKING EXPENSES.			
Labour	£10 per annum.		
Chemicals	£13 per annum.		
Pumping	None.		

Reports of Inspectors: Satisfactory ... 6; Unsatisfactory 9

Analyses: Above limit ... 1; Below limit ... -

Appendix 4.

HEMSWORTH RURAL DISTRICT.—SOUTH KIRKBY SEWAGE WORKS.

Date completed and brought into operation	Summer, 1895.		
Engineer	T. H. Richardson.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained			
Average daily flow of sewage in dry weather			
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only.		
Number of water closets in area drained	Two W.C's.		
LAND.			
Total area	2 acres.		
Whether underdrained, and how?	Yes. 4-inch unsocketted pipes.		
Nett area upon which sewage can be treated	One acre.		
TANKS.			
Number and total capacity	3 tanks. One 16 feet 0 inch × 16 feet 0 inch, and two 16 fee 0 inch × 10 feet 0 inch. Average depth, 3 feet.		
Used all together, or in series	Used in series.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.		
CHEMICALS.			
Nature	Alumino-ferric.		
Quantity	4 cwts. per week.		
How added	In block in channel.		
FILTERS.			
Number and total area	None.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Do.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.		
COST OF—			
Land	(And easements) £351 11*s*. 0*d*.		
Laying out of land	Let in one contract (tank, land, and sewers).		
Tanks			
Filters			
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount			
How dealt with	A small sum paid for carting away.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			
WORKING EXPENSES.			
Labour	£39 per annum.		
Chemicals	£26 per annum.		
Pumping	None.		

Reports of Inspectors: Satisfactory ... 7; Unsatisfactory ... 9

Analyses: Above limit ... 1; Below limit ...

Appendix 4.

HEMSWORTH RURAL DISTRICT.—MIDDLECLIFFE SEWAGE WORKS.

Date completed and brought into operation	1st March, 1899.
Engineer	T. H. Richardson.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	20 houses. Population 100.
Average daily flow of sewage in dry weather	2,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Water from back yards and roofs admitted.
Number of water closets in area drained	None.
LAND.	
Total area	3 roods 21 perches.
Whether underdrained, and how?	Yes. 4-inch unsocketted pipes.
Nett area upon which sewage can be treated	2 roods.
TANKS.	
Number and total capacity	2 tanks. One 16 feet 0 inch × 14 feet 0 inch, and one 14 feet 0 inch × 12 feet 0 inch. Each 3 feet deep.
Used all together, or in series	Used in series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	Lease for 21 years at £7 per annum.
Laying out of land	Let in one contract.
Tanks	Let in one contract.
Filters	Let in one contract.

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Given away.		
Cost, or			
Return			
PRODUCE.			
Crops	None.		
Value			
WORKING EXPENSES.			
Labour	£8 per annum, including Little Houghton.		
Chemicals	None.		
Pumping	Do.		

Reports of Inspectors: Satisfactory ... 4; Unsatisfactory ... –

Analyses: Above limit ... 1; Below limit ... –

Appendix 4.

KEIGHLEY RURAL DISTRICT.—STEETON SEWAGE WORKS.

Date completed and brought into operation	July, 1896.
Engineer	Barber Hopkinson & Co. Keighley.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	309 houses.
Average daily flow of sewage in dry weather	79,200 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage eaves water and some road water.
Number of water closets in area drained	98.
LAND.	
Total area	4 acres 1 rood 2 perches.
Whether underdrained, and how?	Yes. With arthenware pipes th open joints.
Nett area upon which sewage can be treated	2 acres 0 roods 20 perches.
TANKS.	
Number and total capacity	2 tanks. 18,280 gallons.
Used all together, or in series	Used alternately.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement.
CHEMICALS.	
Nature	No chemicals.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One at entrance to outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Adjustable valve.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£437 10 0
Laying out of land	£561 7 9
Tanks	£204 9 7
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	—	During these years the sewage farm was let, and the tenant paid a rent of £10 per year.	
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 25; Unsatisfactory ... 23

Analyses { Above limit ... –; Below limit ... –

KEIGHLEY RURAL DISTRICT.—SUTTON AND EASTBURN SEWAGE WORKS.

Date completed and brought into operation	April, 1897.
Engineer	Barber Hopkinson & Co., Keighley.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	574 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage. No surface wa er.
Number of water closets in area drained	285.
LAND.	
Total area	5 acres 0 roods 35 perches.
Whether underdrained, and how?	Yes. With open jointed pipes.
Nett area upon which sewage can be treated	2 acres 3 roods 32 perches.
TANKS.	
Number and total capacity	2 tanks. 30,000 gallons.
Used all together, or in series	Used alternately.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement.
CHEMICALS.	
Nature	No chemicals.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	4 beds. 2 acres 3 roods 32 perches.
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One at entrance to outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Adjustable valve.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	£800 0 0.
Laying out of land	£849 8 11.
Tanks	£233 6 7.
Filters	

	1895.	1896.	1897, from April.
SLUDGE.			
Amount			Say 30 tons.
How dealt with			Used on beds.
Cost, or			
Return			
PRODUCE.			
Crops			Oats, cabbages, turnips, and cauliflowers.
Value			£24 0 0.
WORKING EXPENSES.			
Labour			£44 10 0.
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 17; Unsatisfactory ... 25

Analyses { Above limit ...; Below limit ...

Appendix 4.

KIVETON PARK RURAL DISTRICT.—WALES ROAD SEWAGE WORKS.

Date completed and brought into operation	February 1898.
Engineer	Wm. Atkinson.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	120 houses.
Average daily flow of sewage in dry weather	6,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. No.
Number of water closets in area drained	
LAND.	
Total area	2 acres.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	1¼ acres.
TANKS.	
Number and total capacity	Two, sub-divided each into 3.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous. 12 hours flow only.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	7 grains per gallon.
How added	In mixing chamber.
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	Rented £4 per acre.
Laying out of land	£100.
Tanks	£250.
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	Not in existence.	Not in existence.	Not in existence.
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 8; Unsatisfactory 9 }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

KNARESBOROUGH RURAL DISTRICT—SCRIVEN SEWAGE WORKS.

Date completed and brought into operation	1894.
Engineer	
Whether sanctioned by L.G.B.	No. Private scheme.
Area and population or number of houses drained	30.
Average daily flow of sewage in dry weather	1,000.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage only. Yes.
Number of water closets in area drained	None.
LAND.	
Total area	2 acres.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	2 acres
TANKS.	
Number and total capacity	2 for catching road grit, and cleaned out when necessary.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 2; Unsatisfactory – }

Analyses { Above limit ...; Below limit ... }

Appendix 4.

PENISTONE RURAL DISTRICT.—TIVY DALE, CAWTHORNE, SEWAGE WORKS.

Date completed and brought into operation	April, 1895.
Engineer	Under directions of Estate Clerk of Works.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	33 houses.
Average daily flow of sewage in dry weather	Not known.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water not included.
Number of water closets in area drained	2 water closets.
LAND.	
Total area	3 acres.
Whether underdrained, and how?	Not underdrained.
Nett area upon which sewage can be treated	2½ acres.
TANKS.	
Number and total capacity	1 tank. 16 feet long × 4 feet wide × 3 feet deep. To hold about 1,400 gallons.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Chemicals not used.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	
Construction	Grating for collecting larger solid matter.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Pumped out and carted away on to land.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	2*l.* per year for supervision of irrigation.		
Chemicals			
Pumping			

Reports of Inspector: Satisfactory ... 6; Unsatisfactory ... –

Analyses: Above limit ... ; Below limit ... –

Appendix 4.

RIPON RURAL DISTRICT. SHAROW SEWAGE WORKS.

Date completed and brought into operation	10 years.
Engineer	Sanitary Inspector.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	4 or 5 acres. 300 population.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	About 18.
LAND.	
Total area	950 square yards.
Whether underdrained, and how?	Underdrained, with socket pipes 6 feet apart.
Nett area upon which sewage can be treated	578 yards.
TANKS.	
Number and total capacity	2. 9,275 gallons.
Used all together, or in series	Together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 1; Unsatisfactory ... 3

Analyses: Above limit ..; Below limit ...

Appendix 4.

ROTHERHAM RURAL DISTRICT.—AUGHTON SEWAGE WORKS.

Date completed and brought into operation	1897.
Engineer	B. Godfrey, A.M.Inst.C.E.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	350 estimated population.
Average daily flow of sewage in dry weather	5,250 gallons estimated.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Roof and yard water.
Number of water closets in area drained	One.
LAND.	
Total area	¾ of an acre.
Whether underdrained, and how?	No. Not necessary.
Nett area upon which sewage can be treated	½ an acre.
TANKS.	
Number and total capacity	1 nest of 3. 1,500 galloms each
Used all together, or in series	Continuously.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Nil.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£3 15s. 0d. per annum on a 42 years' lease.
Laying out of land	Nil.
Tanks	£100.
Filters	Nil.

	1895.	1896.	1897.
SLUDGE.			
Amount			Not known.
How dealt with			Dug into the land.
Cost, or			Nil.
Return			Do.
PRODUCE.			
Crops			To be planted this year, 1898.
Value			
WORKING EXPENSES.			
Labour			£2 per annum.
Chemicals			Nil.
Pumping			Do.

Reports of Inspectors { Satisfactory ... 13; Unsatisfactory ... 1

Analyses { Above limit ...; Below limit ... –

Appendix 4.

SEDBERGH RURAL DISTRICT.—SEDBERGH SEWAGE WORKS.

Date completed and brought into operation	March, 1895.
Engineer	W. H. Radford, Nottingham.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	No. of houses, 300.
Average daily flow of sewage in dry weather	30,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. The surface water of about half the area is included.
Number of water closets in area drained	232.
LAND.	
Total area	4 acres 1 rood 23 perches.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	About 4 acres.
TANKS.	
Number and total capacity	One Ives tank. 15 feet deep by 9 feet diameter, through which the sewage runs continuously.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	Used sparingly in a cage at entrance of tank.
How added	
FILTERS.	
Number and total area	None.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Three.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	They are fixed so high that it has to be an exceptionally storm before they act.
COST OF—	
Land	£807 13 0.
Laying out of land	£10 0 0.
Tanks	£60 0 0.
Filters	

	1895.	1896.	1896.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Vegetables.	Vegetables.	Vegetables.
Value	£35 16 2.	£57 4 7.	£33 2 6.
WORKING EXPENSES.			
Labour	£33 15 0.	£65 0 0.	£56 2 6.
Chemicals	£11 17 7.		
Pumping			

Reports of Inspectors { Satisfactory ... 6; Unsatisfactory ... 2

Analyses { Above limit ... –; Below limit ...

Appendix 4.

SETTLE RURAL DISTRICT.—GIGGLESWICK SEWAGE WORKS.

Date completed and brought into operation	1880.
Engineer	William Goldsworth, Prescot, Lancashire.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Approximate population, 786.
Average daily flow of sewage in dry weather	23,580.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Partly.
Number of water closets in area drained	
LAND.	
Total area	4 acres 1 rood 28 perches.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	3 acres 2 roods 0 perches.
TANKS.	
Number and total capacity	One. 2,700 gallons.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	Nil.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	Leased for 30 years from 14th February, 1879, at a rent of £70 17*s.* 6*d.*, including the Settle Field.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Broad irrigation.		
Cost, or			
Return			
PRODUCE.			
Crops	Grass. The	is let at £20 per annum.	
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 18; Unsatisfactory – }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

SETTLE RURAL DISTRICT.—HELLIFIELD SEWAGE WORKS.

Date completed and brought into operation	1895.
Engineer	A. C. Preston, C.E., Bradford.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Approximate population, 618.
Average daily flow of sewage in dry weather	18,600.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Partly.
Number of water closets in area drained	
LAND.	
Total area	4 acres.
Whether underdrained, and how?	Earthenware pipes.
Nett area upon which sewage can be treated	$3\frac{3}{4}$ acres.
TANKS.	
Number and total capacity	One. 6 feet × 6 feet × 6 feet.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£1,000.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			Let at £10 per year
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 21; Unsatisfactory ... 1 }

Annlyses { Above limit ... –; Below limit ... }

Appendix 4.

SETTLE RURAL DISTRICT.—SETTLE AND LANGCLIFFE SEWAGE WORKS.

Date completed and brought into operation	1880.
Engineer	William Goldsworth, Prescot, Lancashire.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Approximate population—Settle 2,553, Langcliffe 456, Stackhouse 57
Average daily flow of sewage in dry weather	On 31st January 1898, the discharge was 480,000 gallons in 24 hours.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, and 6,000 gallons of refuse from paper mill. Yes.
Number of water closets in area drained	
LAND.	
Total area	5 acres 2 roods 32 perches.
Whether underdrained, and how?	Broad irrigation.
Nett area upon which sewage can be treated	5 acres.
TANKS.	
Number and total capacity	4 tanks each 1,350 gallons, 2 tanks each 5,775 gallons = 16,950 gallons.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	Leased for 30 years from 14th February 1879, at a rental of £70 17*s.* 6*d.*, including the Giggleswick field.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Carted away by farmers.		
Cost, or			
Return			
PRODUCE.			
Crops	Grass. Let for £23 10*s.* 0*d.* per year.		
Value			
WORKING EXPENSES.			
Labour	3*s.* 6*d.* per week.		
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 15; Unsatisfactory ... 2 }

Analyses { Above limit ...; Below limit ... }

Appendix 4.

SETTLE RURAL DISTRICT.—STAINFORTH SEWAGE WORKS.

Date completed and brought into operation	May, 1897.
Engineer	Barber Hopkinson & Co., Keighley.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Approximate population, 180.
Average daily flow of sewage in dry weather	5,400 gallons per day.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Partly.
Number of water closets in area drained	
LAND.	
Total area	$1\frac{1}{2}$ acres.
Whether underdrained, and how?	9 inch pipes.
Nett area upon which sewage can be treated	1 acre.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	£310
Laying out of land	Estimated £225.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			Not planted or let in 1897
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 8; Unsatisfactory ... – }

Analyses { Above limit ...; Below limit ... }

Appendix 4.

SKIPTON RURAL DISTRICT.—ADDINGHAM SEWAGE WORKS.

Date completed and brought into operation	1896. (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	500 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Some surface water.
Number of water closets in area drained	
LAND.	
Total area	Four acres.
Whether underdrained, and how?	I.D.F.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	Two small tanks.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	On sludge bed and carted away.		
Cost, or			
Return			
PRODUCE.			
Crops	Garden produce.	Garden produce.	Garden produce.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 16; Unsatisfactory ... – }

Analyses { Above limit ... 1; Below limit ... – }

Appendix 4.

SKIPTON RURAL DISTRICT.—EARBY SEWAGE WORKS.

Date completed and brought into operation	1896. (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	610 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade waste.
Number of water closets in area drained	
LAND.	
Total area	7 acres.
Whether underdrained, and how?	3 acres I.D.F.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	2 tanks.
Used all together, or in series	Alternately.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One at outfall wor
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Adjustable valves.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Garden produce.		
Value			
WORKING EXPENSES			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 6; Unsatisfactory ... 22 }

Analyses { Above limit ... ; Below limit ... 1 }

Appendix 4.

TADCASTER RURAL DISTRICT.—CROSSGATES, BARWICK-IN-ELMET, SEWAGE WORKS.

Date completed and brought into operation	Completed during the year 1887.
Engineer	Mr. Hodgson Denham.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	About 260 houses, with a population of 1,300.
Average daily flow of sewage in dry weather	About 13,000 gallons daily.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. From yards only.
Number of water closets in area drained	About 4 W.C.'s.
LAND.	
Total area	¾ of an acre.
Whether underdrained, and how?	Yes. Land tiles 3 inch × 4 inch and 6 inch.
Nett area upon which sewage can be treated	½ of an acre.
TANKS.	
Number and total capacity	
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	About 4 tons a year.
How added	One cake always standing in stream of sewage.
FILTERS.	
Number and total area	Four. 18 feet square. Each 3 feet deep.
Construction	Built of brick, charged with chequers, coke breeze and sand.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	One each week, allowed 3 weeks for clearing out. Not Dibdin method. Mr. Denham method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One to flow on land only.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	None.
Proportion of flow in sewer to average flow when storm overflows begin to act	About one-third more sewage than ordinary flow is added when wet.
COST OF—	
Land	Loan obtained was 1,500*l.*
Laying out of land	About 100*l.*
Tanks	
Filters	About 123*l.*

	1895.	1896.	1897.
SLUDGE.			
Amount	About 7 tons.	About 9 tons.	About 10 tons.
How dealt with	Carted on land.	Carted on land.	Carted on land.
Cost, or	No account kept.	No account kept.	No account kept.
Return			
PRODUCE.			
Crops	Rhubarb.	Rhubarb.	Rhubarb.
Value	No account kept.	No account kept.	No account kept.
WORKING EXPENSES.			
Labour	15*l.* a year.	15*l.* a year.	15*l.* a year.
Chemicals	do.	12*l.* do.	12*l.* do.
Coke breeze and recharging filters	16*l.* do.	16*l.* do.	16*l.* do.

Reports of Inspectors { Satisfactory ... 16; Unsatisfactory 2

Analyses { Above limit ... –; Below limit ... –

Appendix 4.

TADCASTER RURAL DISTRICT.—KIPPAX SEWAGE WORKS.

Date completed and brought into operation	September 1889.
Engineer	Messrs. Brundall, Simmons and Brundall, and Denham.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	About 699 houses. Population about 2,796.
Average daily flow of sewage in dry weather	About 13,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. No.
Number of water closets in area drained	About 4 W.C.'s.
LAND.	
Total area	About four acres.
Whether underdrained, and how?	About one acre laid with 3 inch land tiles.
Nett area upon which sewage can be treated	Four acres.
TANKS.	
Number and total capacity	Two tanks. 540 feet square. Each 4 feet 6 inches deep.
Used all together, or in series	In series. Changed weekly.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow into one tank until changed. Water drained from tank on land and solids to filter bed.
CHEMICALS.	
Nature	No.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	One filter. 18 feet square, 3 feet deep.
Construction	Coke breeze and sand.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	For straining water from solid sewage. Not on Dibdin's method; Mr. Denham's settling tank.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One line of sewers to works. Two outlets on to land.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	No.
Proportion of flow in sewer to average flow when storm overflows begin to act	About one third more sewage after heavy rains, which gets into sewers from yards.
COST OF—	
Land	Leased for 30 years at £13 a year.
Laying out of land	
Tanks	About £140 and filter included.
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			About 1 ton per week.
How dealt with			Spread on land.
Cost, or			No account kept.
Return			Do
PRODUCE.			
Crops			Root and corn crops.
Value			No account kept.
WORKING EXPENSES.			
Labour			£7 a year and land for cultivating same.
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 6; Unsatisfactory 4 }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

WAKEFIELD RURAL AND ARDSLEY URBAN DISTRICTS.—WRENTHORPE SEWAGE WORKS.

Date completed and brought into operation	Early in 1897.
Engineer	Frank Massie, Assoc. M. Inst. C. E., Wakefield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	1,000 acres. 5,670 No. of persons.
Average daily flow of sewage in dry weather	No record. Probably 90,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water is excluded as far as it possibly can.
Number of water closets in area drained	Comparatively few. No exact record.
LAND.	
Total area	12 acres 3 roods 30 perches.
Whether underdrained, and how?	The area upon which the tank area is treated is underdrained with subsoil pipe.
Nett area upon which sewage can be treated	4 acres.
TANKS.	
Number and total capacity	Two of Candy's flow tanks, each 14 feet 6 inch diameter.
Used all together, or in series	Separately.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	16 tons per annum.
How added	Blocks are placed in the inlet channel.
FILTERS.	None. Since 9th August 1898, the sewage from 700 persons has been experimentally treated on 3 primary and 3 secondary bacteria beds on the Dibdin system.
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Six.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs
Proportion of flow in sewer to average flow when storm overflows begin to act	No record.
COST OF—	
Land	£2,717.
Laying out of land, Tanks, Filters	£2,565.

	1895.	1896.	1897.
SLUDGE.			
Amount	Not in operation.	Not in operation.	No record.
How dealt with	Allowed to dry in lagoons and then worked into the land.		
Cost, or Return	Not in operation.	Not in operation.	No record.
PRODUCE.			
Crops			Rye grass.
Value			
WORKING EXPENSES.			
Labour			£108.
Chemicals			£40.
Pumping			None.

Reports of Inspectors: Satisfactory ... 23; Unsatisfactory ... 1

Analyses: Above limit ... 2; Below limit ... –

Appendix 4.

WAKEFIELD RURAL DISTRICT.—NEW JERUSALEM SEWAGE WORKS.

Date completed and brought into operation	1890.		
Engineer	Arthur Fawcett, Assoc.M.Inst.C.E., Wakefield.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	110 acres. 1,000 persons.		
Average daily flow of sewage in dry weather	No exact record, probably 15,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water excluded as far as possible.		
Number of water closets in area drained	Very few.		
LAND.			
Total area	3 acres.		
Whether underdrained, and how?	Yes, but they have since been most blocked up.		
Nett area upon which sewage can be treated	The laying out of the land was never completed. The matter is now before the L.G.B.		
TANKS.			
Number and total capacity	Three. 31,000 gallons.		
Used all together, or in series	Together.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	Alumino-ferric.		
Quantity	5 tons per annum.		
How added	Blocks are placed in the inlet channel.		
FILTERS.			
Number and total area	None.		
Construction	Do.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Do.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.		
COST OF—			
Land	£210.		
Laying out of land	Not yet laid out.		
Tanks	No record.		
Filters	None.		
	1895.	1896.	1897.
SLUDGE.			
Amount	No record.	No record.	No record.
How dealt with	Dried in lagoons and spread on land when dry.		
Cost, or	No separate record kept.		
Return	None.	None.	None.
PRODUCE.			
Crops	None save grazing grass.		
Value	£4	£3	£3.
WORKING EXPENSES.			
Labour	£34	£36	£35
Chemicals	£2	£17	£11
Pumping			

Reports of Inspectors { Satisfactory ... 20; Unsatisfactory ... 1 }

Analyses { Above limit ... 1; Below limit ... – }

Appendix 4.

WAKEFIELD RURAL DISTRICT.—NEW SHARLSTON SEWAGE WORKS.

Date completed and brought into operation	
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	100 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	
LAND.	
Total area	None.
Whether underdrained, and how?	Do.
Nett area upon which sewage can be treated	Do.
TANKS.	
Number and total capacity	Four tanks.
Used all together, or in series	Three all together, and one for another part of sewage.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	?
How added	Placed in channel.
FILTERS.	
Number and total area	6. Total area 14 square feet.
Construction	Coke.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. Not Dibdin's.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One at works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Moveable.
Proportion of flow in sewer to average flow when storm overflows begin to act	?
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Carted on to land.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 4; Unsatisfactory 7 }

Analyses { Above li it ... –; Below imit ... }

Appendix 4.

WORTLEY RURAL DISTRICT.—ECCLESFIELD SEWAGE WORKS.

Date completed and brought into operation	April, 1894.		
Engineer	D. Balfour, Newcastle-on-Tyne, for farm proper; outside works, [G. E. Beaumont, Engineer and Surveyor of District Council.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	4,000 population. No definite area.		
Average daily flow of sewage in dry weather	Summer flow 15 gallons per head.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Surface water admitted from roofs and back yards.		
Number of water closets in area drained	23, three of which are not connected to main sewer.		
LAND.			
Total area	5 acres.		
Whether underdrained, and how?	Yes, by socketted pipes under walks and dividing ridges.		
Nett area upon which sewage can be treated	$3\frac{1}{2}$ acres.		
TANKS.			
Number and total capacity	Two.		
Used all together, or in series	Alternatively, except in wet weather, when both used together.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	Alumino-ferric.		
Quantity	About 12 tons annually.		
How added	In slabs in mixing chamber.		
FILTERS.			
Number and total area	No artificial filter except coke cage in each settling tank.		
Construction			
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method			
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	One on line of sewers and one at outfall works.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weir in sewer; penstock or half grate at works.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Half full in sewer and works both.		
COST OF—			
Land	£1,000 exclusive of legal and tenant-right charges.		
Laying out of land	£2,100 inclusive.		
Tanks			
Filters			
	Sept. 30, 1895, to Sept. 30, 1896.	To Sept. 30, 1897.	To Sept. 30, 1898.
SLUDGE.			
Amount	About 50 tons yearly sold, and some dug in.		
How dealt with	Sold to farmer at 6*d.* per load.		
Cost, or			
Return	24*s.*	24*s.*	24*s.*
PRODUCE.			
Crops	Vegetables, ryegrass, and willows.		
Value	£22 0*s.* 5*d.*	£31 15*s.* 11*d.*	*£25 11*s.* 5*d.*
WORKING EXPENSES.			
Labour	One man at 23*s.* per week (house, coal, gas, and water free), assistance (pumping sludge) average 3*s.* per week.		
Chemicals	£35 per annum.		
Pumping	No pumping except of sludge.		

* Over £12 12*s.* 0*d.* outstanding for vegetables, which accounts for reduction in receipts for last period.

Reports of Inspectors { Satisfactory ... 19; Unsatisfactory ... – }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

WORTLEY RURAL DISTRICT.—WADSLEY ASYLUM SEWAGE WORKS.

Date completed and brought into operation	1887.
Engineer	West Riding Surveyor.
Whether sanctioned by L.G.B.	I believe so.
Area and population or number of houses drained	Nearly 2,000 population.
Average daily flow of sewage in dry weather	About 80,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Nearly all domestic. Only a small quantity of surface water included.
Number of water closets in area drained	About 200 W.C.'s.
LAND.	
Total area	Nearly 200 acres.
Whether underdrained, and how?	
Nett area upon which sewage can be treated	39½ acres (irrigation land).
TANKS.	
Number and total capacity	We have two straining tanks, used on alternate days.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	Do.
Construction	Do.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Do.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... ; Unsatisfactory 6

Analyses { Above limit ... – ; Below limit ... –

Appendix 4.

SETTLEMENT OR CHEMICAL PRECIPITATION, FOLLOWED BY ARTIFICIAL FILTRATION.

ARDSLEY URBAN DISTRICT.—ARDSLEY PROPER SEWAGE WORKS.

Date completed and brought into operation	28 May 1896.
Engineer	Mr. T. S. McCallum, Manchester.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population draining to works about 4,000.
Average daily flow of sewage in dry weather	About 14,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Small portion of surface water included.
Number of water closets in area drained	19.
LAND.	
Total area	7 acres.
Whether underdrained, and how?	Not yet executed.
Nett area upon which sewage can be treated	$2\frac{1}{4}$ acres available for effluent by gravitation.
TANKS.	
Number and total capacity	Two tanks. Each 19 feet 0 inch diameter × 13 feet 0 inch deep = 47,000 gallons.
Used all together, or in series	Sometimes together and sometimes singly, according to flow.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	Thirty tons per year.
How added	Basket in mixing channel.
FILTERS.	
Number and total area	No. 4. Each 30 feet × 15 feet = 200 square yards.
Construction	Depth of filtering material about 2 feet 5 inch, top layer sand, next layer polarite and sand mixed, below sand and gravel.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One on sewers and one at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs on sewer and at works.
Proportion of flow in sewer to average flow when storm overflows begin to act	7 to 10 times.
COST OF—	
Land	£1,000.
Laying out of land	Not done yet.
Tanks	About £500.
Filters	About £240 (not including filtering material).

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Part run into lagoons, dried and disposed of to farmers as manure, part pumped into large pit to a level land.		
Cost, or			
Return			
PRODUCE.			
Crops			Nil.
Value			
WORKING EXPENSES.			
Labour			£85 per year.
Chemicals			30 tons per year. £85 per year. Paraffin and other expenses about £15 per year.
Pumping			

Reports of Inspectors. Satisfactory ... 19; Unsatisfactory 1

Analyses: Above limit ... 4; Below limit ... –

Appendix 4.

BAILDON URBAN DISTRICT.—BAILDON SEWAGE WORKS.

Date completed and brought into operation	1893.		(Information not supplied by Authority.)
Engineer	Jaggers.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	600 houses. 3,000 population.		
Average daily flow of sewage in dry weather			
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.		
Number of water closets in area drained			
LAND.			
Total area	4½ acres.		
Whether underdrained, and how?	No land filtration.		
Nett area upon which sewage can be treated			
TANKS.			
Number and total capacity	Two tanks		
Used all together, or in series	In series.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature			
Quantity			
How added			
FILTERS.			
Number and total area	8 small filters. 920 square yards.		
Construction	Domestic ashes.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	None.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.		
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.		
COST OF—			
Land			
Laying out of land			
Tanks			
Filters			
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount			
How dealt with	Run on land and carted.		
Cost, or			
Return			
PRODUCE.			
Crops	None.	None.	None.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 18
Unsatisfactory 4

Analyses { Above limit ... 2
Below limit ... 2

Appendix 4.

BATLEY BOROUGH URBAN DISTRICT.—BATLEY SEWAGE WORKS.

Date completed and brought into operation	About August, 1889.
Engineer	Mr. J. W. Horsfield, Borough Engineer.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	2,039 acres. 31,865 population.
Average daily flow of sewage in dry weather	500,000 gallons in 24 hours.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with some trade refuse which finds its way into the sewers. Surface water also, but not all.
Number of water closets in area drained	About 600.
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	Ten. 435,217 gallons.
Used all together, or in series	All together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Lime (best Buxton) and sometimes lime and alumino-ferric.
Quantity	Average, 15 grains per gallon. The latter 7 grains of each per gallon.
How added	Every quarter of an hour through a mixing machine.
FILTERS.	
Number and total area	Eight. 3,528 square feet superficial.
Construction	Square filters charged with live coke 2 feet deep.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. Not Dibdin's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	At sewer outfall works, one with adjustable valve.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	On line of sewers, 5 fixed side weirs, 2 leaping weirs, 3 adjustable valves. Total 11.
Proportion of flow in sewer to average flow when storm overflows begin to act	About twice the quantity.
COST OF—	
Land	3½ acres. £3,900.
Laying out of land Tanks Filters	£7,212 4*s.* 11*d.*

	1895.	1896.	1897.
SLUDGE.			
Amount	About 200 tons.	About 200 tons.	About 200 tons.
How dealt with	Removed by local farmers for tillage.		
Cost, or	Nil.	Nil.	Nil.
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	£228 0*s.* 3*d.*	£267 1*s.* 0*d.*	£243 2*s.* 1*d.*
Chemicals	£121 13*s.* 7*d.*	£149 2*s.* 4*d.*	£135 2*s.* 7*d.*
Pumping	£232 4*s.* 3*d.*	£168 9*s.* 8*d.*	£148 1*s.* 1*d.*

Reports of Inspectors: Satisfactory ... 4; Unsatisfactory ... 27

Analyses: Above limit ... 1; Below limit ... 4

Appendix 4.

BINGLEY URBAN DISTRICT. COTTINGLEY SEWAGE WORKS.

Date completed and brought into operation	1894. (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic.
Number of water closets in area drained	
LAND.	
Total area	None.
Whether underdrained, and how?	Do.
Nett area upon which sewage can be treated	Do.
TANKS.	
Number and total capacity	2 tanks.
Used all together, or in series	Alternately.
Whether flow of sewage continuous, or time allowed for settlement	
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	2 small filters
Construction	Ashes.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One on line of sewers.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors {Satisfactory ... 7; Unsatisfactory ... 17}

Analyses {Above limit ... –; Below limit ... –}

Appendix 4.

BINGLEY URBAN DISTRICT.—CULLINGWORTH, No. 2, SEWAGE WORKS.

Date completed and brought into operation	1899. (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	72 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade refuse.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	Large circular Ives tank.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	
Construction	Bed of engine ashes.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	96	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 5; Unsatisfactory ... 3 }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

BIRKENSHAW URBAN DISTRICT.—BIRKENSHAW SEWAGE WORKS.

Date completed and brought into operation	Works not yet completed.
Engineer	Wm. Crutchley, C.E., Wakefield.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Area 925 acres. Population 2,479.
Average daily flow of sewage in dry weather	107,460 gallons per 12 hours.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Part surface water.
Number of water closets in area drained	All the water closets are drained (30).
LAND.	
Total area	None.
Whether underdrained, and how?	Do.
Nett area upon which sewage can be treated	Do.
TANKS.	
Number and total capacity	2. Each used separately. 46,850 cubic feet.
Used all together, or in series	Used in series.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	12 tons per year.
How added	One cake used per day.
FILTERS.	
Number and total area	One filter. Total area 9,630 cubic feet.
Construction	Broken stones and sand.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. Not Dibdin's.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One on line at outfall works and three on line of sewers.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	18 inch pipe, 12 inch full.
COST OF—	
Land	£782 9*s.* 11*d.*
Laying out of land	£4,664 4*s.* 5½*d.* (Laying out of land, Tanks, Filters)
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	Ten tons per month.		
How dealt with	Carted on land by farmers.		
Cost, or Return	None.		
PRODUCE.			
Crops	None.	None.	None.
Value	Do.	Do.	Do.
WORKING EXPENSES.			
Labour	£132 1 4	£103 5 7.	£274 16 9.
Chemicals	None.	None.	None.
Pumping	Do.	Do.	Do.

Reports of Inspectors: Satisfactory ... 23; Unsatisfactory ... 5

Analyses: Above limit ... 1; Below limit ... 1

Appendix 4.

BIRSTALL URBAN DISTRICT.—BIRSTALL SEWAGE WORKS.

Date completed and brought into operation	August, 1896. Tested 2½ years prior to 1896.
Engineer	William Birch, Manchester.
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	1,245 acres. 6,528 population. About 1,800 houses.
Average daily flow of sewage in dry weather	About 150,000.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Chiefly domestic. Yes.
Number of water closets in area drained	About 80.
LAND.	
Total area	2¼ acres.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	None.
TANKS.	
Number and total capacity	4 sludge settling tanks, 9,800 gallons; then 10; one continuous precipitating tank, 50,300 gallons. 95 feet 0 inch × 17 feet 0 inch × 5 feet 0 inch.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric in cakes.
Quantity	20 tons a year.
How added	Dissolved by flood of sewage.
FILTERS.	
Number and total area	2 filters of revolving cloths each 20 yards long and 4½ feet wide revolving on drums once round in 20 minutes.
Construction	Revolving cloths on drums.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously. Birch's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One pipe overflow in Kirkgate. One open overflow at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed in Kirkgate. Adjustable valve at outfall works.
Proportion of flow in sewer to average flow when storm overflows begin to act	Twice at least (ordinary rain).
COST OF—	
Land	£2,572 15*s.* 0*d.*
Laying out of land	£461 11*s.* 9*d.* Building fence wall all round and entrance gates.
Tanks	£1,605 7*s.* 1*d.* (Tanks and Filters)
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	250 tons.	280 tons.	300 tons.
How dealt with	Taken on to farm land.		
Cost, or	1*s.* a ton leading to land.		
Return	None.		
PRODUCE.			
Crops	Do.		
Value	Do.		
WORKING EXPENSES.			
Labour	£50 7 11	£80 10 4	£119 6 8
Chemicals	£28 18 11	£52 12 7	£68 11 3
Pumping			

Reports of Inspectors: Satisfactory ... 15; Unsatisfactory ... 20

Analyses: Above limit ... 1; Below limit .. 4

Appendix 4.

BRADFORD COUNTY BOROUGH.—FRIZINGHALL SEWAGE WORKS.

Date completed and brought into operation	1874. (Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	10,776 acres. Population 216,361 (1891).
Average daily flow of sewage in dry weather	19,000,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade refuse. Yes.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	No land treatment.
TANKS.	
Number and total capacity	34 tanks. 612,000 gallons.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Ferric-sulphate.
Quantity	
How added	In solution.
FILTERS.	
Number and total area	34 filters.
Construction	1 sand, 1 carbonized night soil, 3 engine ashes, 24 coke breeze, 3 clinkers, and 2 bacteria.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	About 50.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Carted away.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors {Satisfactory ... 48; Unsatisfactory ... 14} ... Analyses {Above limit ... –; Below limit ... 5}

Only a small proportion of the sewage of Bradford is treated.

Appendix 4.

BRADFORD COUNTY BOROUGH.—SANDY LANE BOTTOM SEWAGE WORKS.

Date completed and brought into operation	1896. (Information not supplied by Authority.)
Engineer	J. H. Cox, Esq.
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	138 houses.
Average daily flow of sewage in dry weather	14,400 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	Ives' tank.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	
How added	In solution.
FILTERS.	
Number and total area	3 filter tanks. Each 24 feet × 15 feet × 3 feet 6 inches.
Construction	Engine ashes and coal.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. No.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One on sewers. One at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Carted on to land by farmer.		
Cost, or			
Return			
PRODUCE.			
Crops	Grass.	Grass.	Grass.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 21; Unsatisfactory 5 }

Analyses { Above limit ... 1; Below limit ... }

Appendix 4.

GOLCAR URBAN DISTRICT.—CRIMBLE SEWAGE WORKS.

Date completed and brought into operation	About 16 or 17 years ago.
Engineer	John Hanson & Co.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	162 houses drained to Crimble Works.
Average daily flow of sewage in dry weather	Cannot say.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with refuse. Surface water included.
Number of water closets in area drained	12.
LAND.	
Total area	No land treatment.
Whether underdrained, and how?	Do.
Nett area upon which sewage can be treated	Do.
TANKS.	
Number and total capacity	2 tanks, 28 feet × 20 feet, 2 feet 9 inch deep. 3 tanks, 20 feet × 20 feet, 4 feet 0 inch deep.
Used all together, or in series	All together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric and lime.
Quantity	2 cwts. each per day.
How added	Automatically.
FILTERS.	
Number and total area	2 filters. Total area 33 feet × 22 feet. 2 feet deep.
Construction	Coke and tiles.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	Cannot say.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount		25 tons per week.	
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour		25*s.* per week.	
Chemicals		8*s.* per day.	
Pumping		Gravitation.	

Reports of Inspectors. { Satisfactory ... 2; Unsatisfactory 15 }

Analyses { Above limit ...; Below limit 2 }

Appendix 4.

HUDDERSFIELD COUNTY BOROUGH.—DEIGHTON SEWAGE WORKS.

Date completed and brought into operation	June, 1893.
Engineer	R. S. Dugdale, C.E.
Whether sanctioned by L.G.B.	No. By special Act of Parliament.
Area and population or number of houses drained	About 9,000 acres with a population of 80,000.
Average daily flow of sewage in dry weather	7,000,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Both domestic and trade refuse. Surface water is included.
Number of water closets in area drained	3,650.
LAND.	
Total area	61 acres. Works and tanks stand on 7½ acres.
Whether underdrained, and how?	
Nett area upon which sewage can be treated	No land filtration.
TANKS.	
Number and total capacity	24 tanks having a total capacity of 211,200 cubic feet.
Used all together, or in series	Used separately.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Lime (Buxton) and Copperas.
Quantity	4·5 grains of lime and 4·0 grains of copperas per gallon on an average.
How added	Lime as thin milk of lime some distance before the copperas.
FILTERS.	
Number and total area	24. Total area 4,464 yards.
Construction	Polarite filters, which are being taken out and replaced by cinder filters worked on Dibdin's method.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	22 on line of sewers and 1 at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Mostly fixed side weirs, remainder are leaping weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	6 to 1.
COST OF—	
Land	£15,615.
Laying out of land	Works £102,000.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	4,049 tons (cake).	11,744.	6,315.
How dealt with	Tipped to form a banking, except a little blown on to waste land.		
Cost, or			
Return			
PRODUCE.			
Crops	None.	None.	None.
Value			
WORKING EXPENSES.			
Labour	£2,314 8 11.	£2,604 12 7.	£2,657 17 10.
Chemicals	£2,020 2 6. (Ferozone.)	£3,612 1 3. (Ferozone.)	£1,170 2 0. (Ferozone and Bauxite precipitant.)
Pumping			

Reports of Inspectors { Satisfactory ... – ; Unsatisfactory ... 20 }

Analyses { Above limit ... – ; Below limit ... 3 }

Appendix 4.

LIVERSEDGE URBAN DISTRICT.—LIVERSEDGE SEWAGE WORKS.

Date completed and brought into operation	26th November, 1885.
Engineer	Charles Gott, C.E.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Liversedge only. Area 2,129 acres 3 roods 12 perches. Population 14,300 (estimated).
Average daily flow of sewage in dry weather	800,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade refuse. Yes.
Number of water closets in area drained	
LAND.	
Total area	20 acres and 32 perches.
Whether underdrained, and how?	Part underdrained.
Nett area upon which sewage can be treated	9 acres 3 roods 14 perches at present, but some 15 or 16 acres are available.
TANKS.	
Number and total capacity	9 tanks. 15,000 gallons.
Used all together, or in series	Used altogether.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settling.
CHEMICALS.	
Nature	Iron ferris and lime.
Quantity	½ ton per week.
How added	A slight flow from mixing tubs.
FILTERS.	
Number and total area	9. Each 48 feet long × 21 feet wide.
Construction	Coke breeze.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Partly on Dibdin's, but as an experiment.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One at the outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Adjustable valves.
Proportion of flow in sewer to average flow when storm overflows begin to act	Cannot say.
COST OF—	
Land	The sewage works, main sewers, buildings, and land cost £40,000 (estimated).
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	Part carted away by local farmers. No return.		Cannot ascertain amount.
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	Cabbages and grass about £20 per year, less labour.		
Value			
WORKING EXPENSES.			
Labour	Estimated £500 annually.		
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... – ; Unsatisfactory ... 31 }

Analyses { Above limit ... – ; Below limit ... 2 }

METHLEY URBAN DISTRICT.—GREEN LANE SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	1893.
Engineer	John Richardson, Esq., M.I.C.E., Methley and Leeds.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	23 houses.
Average daily flow of sewage in dry weather	851 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Partially.
Number of water closets in area drained	None.
LAND.	
Total area	22 perches.
Whether underdrained, and how?	Yes. Land drain pipes.
Nett area upon which sewage can be treated	10 perches.
TANKS.	
Number and total capacity	Four. 1,008 cubic feet.
Used all together, or in series	Series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	None.
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	See above.
Construction	Underdrained and levelled.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land; Laying out of land; Tanks; Filters	Held under lease from J. How. Cost cannot be divided. Total cost of works £5,500.

	1895.	1896.	1897.
SLUDGE.			
Amount	No record.	No record.	No record.
How dealt with	Do.	Do.	Given away.
Cost, or	Do.	Do.	No record.
Return	Do.	Do.	Do.
PRODUCE.			
Crops	Do.	Do.	None
Value	Do.	Do.	Do.
WORKING EXPENSES.			
Labour	Do.	Do.	No record.
Chemicals	Do.	Do.	Do.
Pumping	Do.	Do.	Do.

Reports of Inspectors { Satisfactory ... 14; Unsatisfactory ... 1 }

Analyses { Above limit ... –; Below limit ... – }

Appendix 4.

MONK BRETTON URBAN DISTRICT.—DAY'S CROFT SEWAGE WORKS.

Date completed and brought into operation	February, 1894.
Engineer	J. L. Marshall.
Whether sanctioned by L.G.B.	Not laid before L.G.B.
Area and population or number of houses drained	34 houses.
Average daily flow of sewage in dry weather	3,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic only. Only roof water.
Number of water closets in area drained	None.
LAND.	
Total area	½ an acre
Whether underdrained, and how?	Underdrained by a 6 inch pipe drain into which sewage after filtration percolates through the land.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	One settling tank.
Used all together, or in series	3,300 gallons.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	None
Quantity	Do.
How added	Do.
FILTERS.	
Number and total area	2 sets of 2 each. 10½ yards
Construction	Clinkers, coke breeze, and flue dust.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One storm overflow.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Side weir 2 inches high.
Proportion of flow in sewer to average flow when storm overflows begin to act	No record kept. The storm water is only roof water.
COST OF—	
Land	£5 a year on lease.
Laying out of land	
Tanks	} £120.
Filters	

	1895	1896.	1897.
SLUDGE.	No record kept.		
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 9; Unsatisfactory ... 4

Analyses { Above limit ... –; Below limit ... –

MONK BRETTON URBAN DISTRICT.—SMITHIES' SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	May, 1898.
Engineer	Wade & Turner, Barnsley.
Whether sanctioned by L.G.B.	Not laid before the L.G.B.
Area and population or number of houses drained	154 houses.
Average daily flow of sewage in dry weather	No record kept.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	All domestic sewage. Surface water included.
Number of water closets in area drained	None.
LAND.	
Total area	½ an acre.
Whether underdrained, and how?	Not drained.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	4 tanks. 17,388 gallons, or 8,694 each set of two.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Flow continuous in each series.
CHEMICALS.	
Nature	Spence's alumino-ferric.
Quantity	No record kept
How added	In a solid block placed in channel.
FILTERS.	
Number and total area	2 sets of 2 each. 34⅔ yards area per set.
Construction	Broken rubble, coke breeze, and sand.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Filters used continuously each set (not Dibdin's method).
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	3 on line of sewer.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	1 at outfall. Weirs 2 to 3 inches high.
Proportion of flow in sewer to average flow when storm overflows begin to act	No record kept.
COST OF—	
Land	£8 per year on lease.
Laying out of land	Cost, including the main outfall sewer only, £912.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.	No record kept.		
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 13; Unsatisfactory ... 3

Analyses: Above limit ... -; Below limit ... -

I I 2

Appendix 4.

PONTEFRACT BOROUGH URBAN DISTRICT.—KNOTTINGLEY ROAD SEWAGE WORKS.

Date completed and brought into operation	1881.		
Engineer	Designed by Mr. W. Crutchley, carried out under the Borough [Surveyor.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	4,242 acres. About 13,000 population.		
Average daily flow of sewage in dry weather	340,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic and small quantity of trade refuse. Surface water is included.		
Number of water closets in area drained	About 300.		
LAND.			
Total area	5 acres.		
Whether underdrained, and how?	Not underdrained.		
Nett area upon which sewage can be treated	3 acres, but not used for treatment.		
TANKS.			
Number and total capacity	Three. 700,000 gallons.		
Used all together, or in series	Altogether.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	Lime.		
Quantity	104 tons per year.		
How added	By hopper, and mixed with sewage by water wheel.		
FILTERS.			
Number and total area	Two. 5,150 superficial feet.		
Construction	Enclosed by brick walls, underdrained by perforated pipes, sand and rubble filtering medium.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Two on line of sewer.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	1 fixed, 1 adjustabl		
Proportion of flow in sewer to average flow when storm overflows begin to act	About 6 times dry weather flow in one case, about 12 times in the other.		
COST OF—			
Land	£880.		
Laying out of land			
Tanks	£2,284 6s. 0d., which includes the construction of a portion of the outfall sewer.		
Filters			
	1895.	1896.	1897.
SLUDGE.			
Amount	Cannot give.		
How dealt with	Sold by auction for agricultural purposes.		
Cost, or			
Return	£5 15 6	£5 12 0	£7 11 0
PRODUCE.			
Crops	None.		
Value	Do.		
WORKING EXPENSES.			
Labour	£185 10 0	£185 10 0	£185 10 0
Chemicals	£52 0 0	£52 0 0	£52 0 0
Pumping			

Reports of Inspectors { Satisfactory ... ; Unsatisfactory ... 19 }

Analyses { Above limit ... – ; Below limit ... 12 }

PUDSEY URBAN DISTRICT.—SMALEWELL SEWAGE WORKS.

Appendix 4.

Date completed and brought into operation	August, 1896.
Engineer	J. H. Rhodes and R. W. Cass.
Whether sanctioned by L.G.B.	There has been a slight departure from plans sanctioned by the L.G.B.
Area and population or number of houses drained	200 acres. Population about 2,000, and 3 mills.
Average daily flow of sewage in dry weather	About 84,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic, and mixed with trade refuse. Partly included.
Number of water closets in area drained	Unable to state definitely.
LAND.	
Total area	5 acres 0 roods 34 perches.
Whether underdrained, and how?	Not underdrained. Falls naturally to beck.
Nett area upon which sewage can be treated	About 1¼ acres by irrigation besides the filter beds.
TANKS.	
Number and total capacity	3 tanks. 115,000 gallons.
Used all together, or in series	Can be used altogether or in series.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed for settlement.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	About 12 tons per annum.
How added	In mixing race as the flow requires.
FILTERS.	
Number and total area	Nine. 2,000 square yards.
Construction	Ballast 9 inch, rough stone 9 inch, fine stone 9 inch, rough ashes 5 inche thick, fine ashes 10 inch thick.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	One.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Leaping weir. To be altered to automatic.
Proportion of flow in sewer to average flow when storm overflows begin to act	When altered the overflow level will be ⅔rds of the diameter of the sewer.
COST OF—	
Land	£700.
Laying out of land	Not laid out.
Tanks	£508 14 8.
Filters	£446 8 6.

	1895.	1896.	1897.
SLUDGE.			
Amount		In 5 months 68 cart loads.	134 cart loads.
How dealt with		By farmers.	
Cost, or			
Return	Nil.	£3 10 0	£7 0 0
PRODUCE.			
Crops	Do.	Nil.	Nil.
Value	Do.	Do.	Do.
WORKING EXPENSES.			
Labour		(5 months.) £40 5 6	£82 14 8
Chemicals		£13 18 9	£33 7 7
Pumping	Do.	Nil	Nil.

Reports of Inspectors { Satisfactory ... 19; Unsatisfactory ... 1 }

Analyses { Above limit ... 1; Below limit ... 1 }

Appendix I.

SHEFFIELD COUNTY BOROUGH.—SHEFFIELD SEWAGE WORKS.

Date completed and brought into operation	1886. (Information not supplied by Authority.)
Engineer	A. G. Alsing.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	15,000,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade refuse. Yes.
Number of water closets in area drained	
LAND.	
Total area	22 acres.
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	90 tanks. 3,000,000 gallons.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Time allowed.
CHEMICALS.	
Nature	Lime.
Quantity	About 7 grains per gallon.
How added	Mechanical mixers.
FILTERS.	
Number and total area	6 filters.
Construction	Earth bank with coke breeze medium.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Dibdin's.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Several on line of sewers, one at outfall works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs and leaping weirs.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Tipped on special tip.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors: Satisfactory ... 1; Unsatisfactory ... 36

Analyses: Above limit ... –; Below limit ... 7

UPPERMILL URBAN DISTRICT.—HALLS, UPPERMILL, SEWAGE WORKS. Appendix 4

Date completed and brought into operation	29th July, 1896.
Engineer	Mr. T. S. McCallum, Manchester.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	180 acres. Population about 1,600.
Average daily flow of sewage in dry weather	16,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage. A considerable portion of surface water conveyed to works.
Number of water closets in area drained	15.
LAND.	
Total area	1 acre 0 roods 25 perches.
Whether underdrained, and how?	This portion of work not yet executed.
Nett area upon which sewage can be treated	Nearly 1 acre.
TANKS.	
Number and total capacity	Two tanks. Each 13 feet 3 inch × 9 feet 0 inch deep. 15,000 gallons.
Used all together, or in series	Sometimes together and sometimes singly, according to flow.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	Alumino-ferric at present.
Quantity	
How added	Basket in inlet channel.
FILTERS.	
Number and total area	Two filters. Each 18 feet 0 inch × 15 feet 0 inch = 60 square yards. 40 square yards of cinder filters to be added.
Construction	About 2 feet 5 inch filtering material in centre, made up as follows:—Sand 7 inch, polarite 6 inch, mixed with 4 inch of sand, pea gravel 2 inch, bean gravel 3 inch, walnut gravel 2 inch, boulders 5 inch.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	Two on sewers and two at works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	On sewers practically fixed side weirs, at works one automatic valve and one fixed overflow between tanks and filters.
Proportion of flow in sewer to average flow when storm overflows begin to act	7 to 10 times (all not yet adjusted).
COST OF—	
Land	£650.
Laying out of land	Not done yet.
Tanks	About £350.
Filters	About £200 (not including filtering material).

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Run into lagoons, dried and carted away for manure by farmers.		
Cost, or			
Return			
PRODUCE.			
Crops	No value.		
Value	Do.		

WORKING EXPENSES.	
Labour	£29 11 5½ for year ending 31st March, 1898.
Chemicals	£18 5 1 Do
Pumping	None. Do Other expenditure £49 6 5

Reports of Inspectors { Satisfactory ... 15; Unsatisfactory ... 7 }

Analyses { Above limit ... 3; Below limit ... }

Appendix 4.

WATH-ON-DEARNE URBAN DISTRICT.—WATH SEWAGE WORKS.

Date completed and brought into operation	1892.		
Engineer	The late Mr. H. A. Johnson, of Sheffield.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	2,353 acres. Population 8,238 in 1897.		
Average daily flow of sewage in dry weather	155,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	The sewage is mixed to some extent with trade refuse. Surface water, including roof water, is partially included.		
Number of water closets in area drained	Estimated number 75.		
LAND.			
Total area	Nearly 6½ acres.		
Whether underdrained, and how?	Not underdrained.		
Nett area upon which sewage can be treated	Land very unsuitable. Available area about 5½ acres.		
TANKS.			
Number and total capacity	Four. 27,000 gallons each. Total capacity 108,000 gallons.		
Used all together, or in series	Used in series.		
Whether flow of sewage continuous, or time allowed for settlement	From 2 to 3 hours allowed for settlement.		
CHEMICALS.			
Nature	Alumino-ferric and lime.		
Quantity	20 tons alumino-ferric per annum. 25 tons lime per annum.		
How added	Hand mixed.		
FILTERS.			
Number and total area	5 filters. Total arae 3,600 square feet.		
Construction	Brick and concrete walls, concrete floors, filtering medium gravel and polarite.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. Not on Dibdin's method.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	8 on line of sewers. 1 at outfall works.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	3 valves. Remainder fixed side weirs.		
Proportion of flow in sewer to average flow when storm overflows begin to act	The overflows begin to act when there is from three to four times the ordinary amount of sewage in sewers.		
COST OF—			
Land	£740 1 1		
Laying out of land	All included in one contract.		
Tanks	All included in one contract.		
Filters	All included in one contract.		
	1895.	**1896.**	**1897.**
SLUDGE.			
Amount			700 cubic yards (estimated)
How dealt with			Not dealt with.
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	£149.	£161.	£157.
Chemicals	£50.	£55.	£50.
Pumping	£30.	£30.	£35.

Reports of Inspectors: Satisfactory ... 14; Unsatisfactory 1

Analyses: Above limit 1; Below limit –

Appendix 4.

WORSBOROUGH URBAN DISTRICT.—BIRDWELL COMMON SEWAGE WORKS.

Date completed and brought into operation	1884.
Engineer	W. Senior, Esq., Barnsley.
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	20 houses.
Average daily flow of sewage in dry weather	400 gallons (estimated).
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. No surface water.
Number of water closets in area drained	None.
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	4.
Used all together, or in series	All together.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	
Quantity	
How added	
FILTERS.	
Number and total area	
Construction	
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	Leased.
Laying out of land	About £80.
Tanks	About £80.
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	About £10 a year.		
Chemicals			
Pumping			

Reports of Inspectors. Satisfactory ... ; Unsatisfactory –

Analyses: Above limit ... ; Below limit ... –

Outlet always submerged and pollution hidden.

Appendix 4.

HEMSWORTH RURAL DISTRICT.—WRAGBY SEWAGE WORKS.

Date completed and brought into operation	(Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	20 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	3 tanks.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	
How added	Put in channel.
FILTERS.	
Number and total area	2 filters.
Construction	Sand and coke breeze.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	None.	None.	None.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors {Satisfactory ... 12; Unsatisfactory ... 2}

Analyses {Above limit ... 1; Below limit ...}

Appendix 4.

HEMSWORTH RURAL DISTRICT.—TAYLOR WOOD COTTAGES' SEWAGE WORKS

Date completed and brought into operation	(Information not supplied by Authority.)
Engineer	
Whether sanctioned by L.G.B.	No
Area and population or number of houses drained	8 cottages.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	2 tanks.
Used all together, or in series	In series.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	
How added	Put into channel.
FILTERS.	
Number and total area	1 filter.
Construction	Sand and coke breeze.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors {Satisfactory ... 1 / Unsatisfactory ... –}

Analyses {Above limit ... – / Below limit ... –}

Appendix 4.

HEMSWORTH RURAL DISTRICT.—FOULBY SEWAGE WORKS.

Date completed and brought into operation	(Information not supplied by authority.)
Engineer	
Whether sanctioned by L.G.B.	No.
Area and population or number of houses drained	14 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Yes.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	2 tanks.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	
How added	Put in channel.
FILTERS.	
Number and total area	One filter.
Construction	Sand and coke breeze.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Continuously
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	None.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	None.	None.	None.
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 7; Unsatisfactory ... ·

Analyses { Above limit ... ·; Below limit ... –

Appendix 4.

SADDLEWORTH RURAL DISTRICT.—GREENFIELD AND FRIEZELAND SEWAGE WORKS.

Date completed and brought into operation	
Engineer	Mr. T. S. McCallum, Manchester.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 1,600.
Average daily flow of sewage in dry weather	16,000 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic sewage. Portion of surface water conveyed to works.
Number of water closets in area drained	
LAND.	
Total area	$2\frac{1}{2}$ acres.
Whether underdrained, and how?	Not yet executed.
Nett area upon which sewage can be treated	1 acre.
TANKS.	
Number and total capacity	2 tanks. Each 13 feet 0 inch diameter × 9 feet 0 inch deep. 14,931 gallons.
Used all together, or in series	Sometimes together, sometimes singly, according to flow.
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	About 6 cwt. per week.
How added	Basket in inlet channel.
FILTERS.	
Number and total area	2 beds. Each 17 feet 3 inch × 15 feet 0 inch. 57 square yards.
Construction	About 2 feet 5 inch filtering material in centre, made up as follows:—Sand 7 inch, polarite 6 inch, mixed with sand 4 inch, pea gravel 2 inch, bean gravel 3 inch, walnut gravel 2 inch, boulders 5 inch.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	3 on sewers, 1 at works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weirs on sewers. Automatic arrangement at works.
Proportion of flow in sewer to average flow when storm overflows begin to act	7 to 10 times.
COST OF—	
Land	£714.
Laying out of land	Not yet done.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Run into lagoons, dried and used as manure by farmers.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping	None.		

Reports of Inspectors { Satisfactory ... 16; Unsatisfactory ... – }

Analyses { Above limit ... ; Below limit ... }

Appendix 4.

SADDLEWORTH RURAL DISTRICT.—ROYAL GEORGE AND GRASSCROFT SEWAGE WORKS.

Date completed and brought into operation	
Engineer	Mr. T. S. McCallum, Manchester.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	Population 990.
Average daily flow of sewage in dry weather	9,900 gallons.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic. Portion of surface water conveyed to works.
Number of water closets in area drained	
LAND.	
Total area	1 acre.
Whether underdrained, and how?	Not yet executed.
Nett area upon which sewage can be treated	¾ acre.
TANKS.	
Number and total capacity	1 tank. 14 feet 0 inch diameter × 10 feet 0 inch deep. 9,583 gallons.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	About 5 cwt. per week.
How added	Basket in inlet channel.
FILTERS.	
Number and total area	2 beds. Each 14 feet 3 inch × 12 feet 0 inch. 38 square yards.
Construction	About 2 feet 5 inch filtering material in centre, made up as follows:—Sand 7 inch, polarite 6 inch, mixed with 4 inch sand, pea gravel 2 inch, bean gravel 3 inch, walnut gravel 2 inch, boulders 5 inch.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently.
	———
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	2 on sewers, 1 at works.
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed weirs on sewer, automatic arrangement at works.
Proportion of flow in sewer to average flow when storm overflows begin to act	7 to 10 times.
COST OF—	
Land	£324.
Laying out of land	Not yet done.
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	Run into lagoons dried and used for manure by farmers.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping	None.		

Reports of Inspectors: Satisfactory ... 10; Unsatisfactory ... –

Analyses: Above limit ... –; Below limit ... –

Appendix 4.

WAKEFIELD RURAL DISTRICT.—ALVERTHORPE SEWAGE WORKS.

Date completed and brought into operation	1889.		
Engineer	Arthur Fawcett, Assoc. M.Inst.C.E., Wakefield.		
Whether sanctioned by L.G.B.	Yes.		
Area and population or number of houses drained	1,017 acres. 5,000 population.		
Average daily flow of sewage in dry weather	300,000 gallons.		
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Domestic and trade refuse. Surface water included.		
Number of water closets in area drained	Comparatively few. No exact record.		
LAND.			
Total area	11 acres 1 rood 10 perches.		
Whether underdrained, and how?	Not underdrained.		
Nett area upon which sewage can be treated			
TANKS.			
Number and total capacity	Six. 245,000 gallons.		
Used all together, or in series	In two series.		
Whether flow of sewage continuous, or time allowed for settlement	Continuous.		
CHEMICALS.			
Nature	Lime and alumino-ferric.		
Quantity	100 tons of lime of 24 tons of alumino-ferric.		
How added	Milk of lime and afterwards alumino-ferric in block.		
FILTERS.			
Number and total area	Two. 303 square yards.		
Construction	Coke breeze.		
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. Not on Dibdin's method.		
STORM OVERFLOWS.			
Number on line of sewers and at outfall works	Four.		
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Fixed side weirs.		
Proportion of flow in sewer to average flow when storm overflows begin to act	No record.		
COST OF—			
Land	£1,850.		
Laying out of land	Not laid out.		
Tanks	No record.		
Filters	Do.		
	1895.	1896.	1897.
SLUDGE.			
Amount	No record.	No record.	No record.
How dealt with	Dried in lagoons and then carted away by the farmers, 6*d.* and 9*d.* a load being given them for removing it.		
Cost, or			
Return			
PRODUCE.			
Crops	Grass.	Grass.	Grass.
Value		£12.	£12
WORKING EXPENSES.			
Labour	£250.	£255.	£267
Chemicals	£210.	£158.	£153
Pumping	£39.	£40.	£33.

Reports of Inspectors { Satisfactory ... 5 / Unsatisfactory 23 }

Analyses { Above limit ... – / Below limit ... 1 }

Appendix 4.

WAKEFIELD RURAL DISTRICT.—SPRING LANE, CROFTON, SEWAGE WORKS.

Date completed and brought into operation	
Engineer	
Whether sanctioned by L.G.B.	
Area and population or number of houses drained	130 houses.
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included ?	Domestic sewage.
Number of water closets in area drained	
LAND.	
Total area	
Whether underdrained, and how?	
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	One tank. 2,390 gallons capacity.
Used all together, or in series	
Whether flow of sewage continuous, or time allowed for settlement	Continuous flow.
CHEMICALS.	
Nature	Alumino-ferric.
Quantity	
How added	Placed in channel.
FILTERS.	
Number and total area	3 filters.
Construction	Broken stone (three sizes), sand, and polarite.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. Not Dibdin's method.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount			
How dealt with	On land.		
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour			
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... 5; Unsatisfactory ... 6 }

Analyses { Above limit ...; Below limit ... - }

Appendix 4.

WETHERBY RURAL DISTRICT.—SHADWELL INDUSTRIAL SCHOOL SEWAGE WORKS

Date completed and brought into operation	Several years ago.
Engineer	None. We were guided by the advice of Dr. Cameron, Leeds Medical Officer of Health.
Whether sanctioned by L.G.B.	No. We submitted the scheme to the Home Secretary, who is the authority for Industrial Schools.
Area and population or number of houses drained	180 boys and officers and Superintendent's family. Say 200 in all.
Average daily flow of sewage in dry weather	Regret I cannot give this.
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	There are 2 W.C.'s, lavatory, laundry and for the whole Institution, kitchen sinks, &c. No.
Number of water closets in area drained	2.
LAND.	
Total area	20 acres.
Whether underdrained, and how?	Ordinary land drains connected with beck.
Nett area upon which sewage can be treated	Very little land below level of tanks.
TANKS.	
Number and total capacity	2. Large, with ample capacity. Do not know the precise quantity they will hold.
Used altogether, or in series	Alternately.
Whether flow of sewage continuous, or time allowed for settlement	Plenty of time allowed for settlement.
CHEMICALS.	
Nature	Alumino-ferric cake, and at present oxynite being tried.
Quantity	About 30 grains to gallon.
How added	Put into drain before reaching tanks.
FILTERS.	
Number and total area	No filtration. A fairly satisfactory effluent attained.
Construction	Do
Whether used continuously or intermittently, and (if the latter) whether on Dibden's method	Do.
STORM OVERFLOWS.	
Number on line of sewers and outfall works	None.
Construction—whether fixed side wiers, leaping wiers, or adjustible valves	Do.
Proportion of flow in sewer to average flow when storm overflows begin to act	Do.
COST OF—	
Land	We spent about £400 in the drainage and tanks. I am sorry I cannot apportion it.
Laying out of land	
Tanks	
Filters	

	1895.	1896.	1897.
SLUDGE.			
Amount	The tanks are cleaned at intervals, and the sludge carried on the land. There is very little sludge, and the cost is very trifling, as it is only a question of labour for the big boys under detention.		
How dealt with			
Cost, or			
Return			
PRODUCE.			
Crops	No application to this system.		
Value			
WORKING EXPENSES.			
Labour	Only the small cost of chemicals, quite inappreciable.		
Chemicals			
Pumping			

Reports of Inspectors { Satisfactory ... – ; Unsatisfactory – }

Analyses { Above limit ... – ; Below limit ... }

Appendix 4.

YEADON URBAN DISTRICT.—YEADON SEWAGE WORKS.

Date completed and brought into operation	About 1881.
Engineer	McLandsbro & Preston.
Whether sanctioned by L.G.B.	Yes.
Area and population or number of houses drained	
Average daily flow of sewage in dry weather	
Nature of sewage (domestic or mixed with trade refuse). Is surface water included?	Mixed with trade refuse. Yes.
Number of water closets in area drained	
LAND.	
Total area	4 acres 3 roods 3 perches.
Whether underdrained, and how?	No.
Nett area upon which sewage can be treated	
TANKS.	
Number and total capacity	2 storage tanks, 3 settling tanks.
Used all together, or in series	Altogether.
Whether flow of sewage continuous, or time allowed for settlement	Continuous.
CHEMICALS.	
Nature	Lime.
Quantity	16 tons per month
How added	Mixing machine.
FILTERS.	
Number and total area	1 filter. Area 324 square yards. Two more in course of construction, with an area of about 600 square yards.
Construction	Rubble and rough and fine clinkers.
Whether used continuously or intermittently, and (if the latter) whether on Dibdin's method	Intermittently. No.
STORM OVERFLOWS.	
Number on line of sewers and at outfall works	
Construction—whether fixed side weirs, leaping weirs, or adjustable valves	Adjustable valve.
Proportion of flow in sewer to average flow when storm overflows begin to act	
COST OF—	
Land	Leasehold, £74 15s. 0d. per year.
Laying out of land	
Tanks	
Filters	

	1895.	1896	1897.
SLUDGE.			
Amount			
How dealt with	Given away.	Stored up.	Stored up.
Cost, or			
Return			
PRODUCE.			
Crops			
Value			
WORKING EXPENSES.			
Labour	£223 18 5	£285 2 5	£183 7 11
Chemicals	£59 12 6	£119 13 1	£127 8 0
Pumping			

Reports of Inspectors: Satisfactory ... 2; Unsatisfactory ... 19

Analyses: Above limit ... –; Below limit ... 3

Appendix 4.

SUMMARY.

No.	Treatment and Nature of Sewage.	Reports of Inspectors.		Results of Analyses.		Percentage below limit.
		Satisfactory.	Unsatisfactory.	Above limit.	Below limit.	
	Settlement or Chemical Precipitation, followed by Artificial Filtration and Filtration through Land:					
12	(*a*) Domestic sewage only	152	56	7	4	36
3	(*b*) Sewage mixed with trade refuse	16	51	1	3	75
	Artificial Filtration:					
11	(*c*) Rapid (mechanical ?) filter. Domestic sewage only.	38	100	2	3	60
—	(*d*) Rapid (mechanical ?) filtration. Sewage mixed with trade refuse.	—	—	—	—	—
4	(*e*) Biological filtration. Domestic Sewage only.	7	32	1	—	—
1	(*f*) Biological filtration. Sewage mixed with trade refuse.	8	7	—	—	—
	Filtration through Land:					
46	(*g*) Domestic sewage only	414	181	20	5	20
9	(*h*) Sewage mixed with trade refuse	100	100	3	7	70
	Chemical Precipitation or Settlement:					
10	(*i*) Domestic sewage only	24	74	—	3	100
6	(*j*) Sewage mixed with trade refuse	15	148	—	5	100
	Settlement or Chemical Precipitation, followed by Filtration through Land:					
66	(*k*) Domestic sewage only	684	315	16	12	43
20	(*l*) Sewage mixed with trade refuse	176	256	14	23	62
	Settlement or Chemical Precipitation, followed by Artificial Filtration:					
18	(*m*) Domestic sewage only	205	75	13	7	35
12	(*n*) Sewage mixed with trade refuse	100	209	3	30	91

The period to which the statistics refer is from 1st January, 1898, to 30th September, 1899.

The limit of impurity adopted is absorption of one grain per gallon of oxygen at 80° Fahrenheit.

APPENDIX No. 5.

RIBBLE JOINT COMMITTEE.

PARTICULARS as to the methods of Sewage Treatment adopted by Local Authorities in the Ribble Watershed

NOTE.—In judging the quality of Effluents for regular Monthly Reports, samples liberating less than ·1 Albuminoid Ammonia in parts per 100,000 are classed "good" in the absence of other easily-observed for such Ammonia. Others are classed as "fair" or "poor" according to the amount of Albuminoid Ammonia between these figures. In the following Tables the dividing line between good and bad is ·16 part

NAME OF AUTHORITY.	Population.	Number of Houses connected with Sewers.	Average Daily Flow of Sewage (per 24 Hours) in Gallons.	Number of Firms turning Trade Waste into Sewers, and the Character of Same.	Number of Precipitation Tanks and Total Capacity in Gallons.	Precipitants used.	Quantity of Precipitants used per Week.	Number of Artificial Filters and Total Area of Same.
1.	2.	3.	4.	5.	6.	7.	8.	9.
CHEMICAL PRECIPITATION ONLY.								
(A) DOMESTIC SEWAGE ONLY.								
Upholland Urban District Council (Tontine District).	300	60	7,800	—	3 tanks, 510	Lime and copperas	Lime 112lbs., copperas, 130lbs.	—
(B) SEWAGE MIXED WITH TRADE WASTE.								
None	—	—	—	—	—	—	—	—
PRECIPITATION AND ARTIFICIAL FILTRATION.								
CHEMICAL PRECIPITATION AND RAPID MECHANICAL, OR MECHANICO-BIOLOGICAL, FILTRATION.								
DOMESTIC SEWAGE ONLY.								
Upholland Urban District Council	745	149	17,000	—	2 tanks, 3,074	Lime and copperas	Lime 126lbs., copperas, 200lb.	2 filters, 6⅓ sq. yds.
Darwen Corporation (Hoddlesden District)	500	120	11,000	—	2 tanks, 34,000	Ferrozone and alumino-ferric.	1 cwt.	2 filters, 65 superficial yards.
Chorley Rural District Council (Whittle-le-Woods District).	2,200	308	1,600	—	2 tanks, 10,000	Alumino-ferric	—	3 filters, 89 sq. yds.
Chorley Rural District Council (Wheelton District).	1,600	155	1,600	—	2 tanks, 12,812	Alumino-ferric	—	2 filters
Chorley Rural District Council (Heapey District).	520	46	460	—				
Chorley Rural District Council (Coppull District).	2,100	150	1,500		2 tanks, 4,375	Alumino-ferric	—	2 filters
Longridge Urban District Council	4,500	Three-quarters of the District.	80,000		2 tanks, 46,000	Alumino-ferric	9 cwt. per week	3 filters, 145 sq. yds.
Lathom and Burscough Urban District Council (Westhead).	Estimated about 430	86	5,400	None	1 tank, in 4 compartments: total capacity 9,000.	Alumino-ferric	1½ cwt. per week	4 filters, 196 superficial yards.
Preston Rural District Council (Ribchester).	1,265	—	—	—	—	—	—	—
Nelson Corporation	35,000	6,500	600,000	—	7 tanks; total capacity, about 800,000.	Alumino-ferric	5 tons	10 filters working, 1,100 square yards; 6 in course of construction, 5,000 square yards.
Withnell Urban District Council (Withnell Abbey District).	Estimated about 1,000	—	8,000	—	2 tanks; total capacity, 16,000.	Alumino-ferric	1¾ cwts.	3 filters, 24 square yards
Chorley Corporation	24,550	5,650	750,000	—	8 tanks; capacity, 1,442,800.	Ferral	4 tons 10 cwts.	15 filters, 55ft. 6in. by 15ft. by 3ft. 3in., 1,388 sup. yards.

APPENDIX No. 5.

RIBBLE JOINT COMMITTEE.

Columns 2 to 15 inclusive being replies from Local Authorities to queries put by the Joint Committee.

objections, such as foul smell, excessive turbidity, &c. Those liberating more than ·2 parts per 100,000 are classed "bad" in the absence of any special information suggesting an origin other than "Sewage Matter" of Albuminoid Ammonia per 100,000.

Depth and Character of Filtering Materials.	Method of using Filters (whether Intermittent or Continuous), the Character of Liquid put on, and Volume dealt with per Square Yard of Filter per 24 Hours.	Area of Land used for Filtration or Irrigation.	Area of Land owned but not used for Irrigation Purposes.	Amount of Sludge Produced per Week, and how Disposed of.	Is the Day Treatment continued during the Night?	Number of Samples Above Limit.	Number of Samples Below Limit.	Total Samples.	Percentage of Samples below Limit.	Remarks.
10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
—	—	—	111 sq. yds.	1¼ tons taken away by farmers.	Yes	2	2	4	50	Tank effluents. Portion of Upholland only (small volume).
—	—	—	—	—	—	—	—	—	—	—
Depth 3ft.: — Two sizes of coke breeze 18in., three sizes of gravel 12in., and sand 6in.	Intermittent household sewage, 2,727 gallons.	1,066 sq. yds.	4 acres	5½ tons given to farmers.	Yes	9	8	17	47	Filter effluents.
Magnetite, sand, gravel, depth 3ft. 6in.	Intermittent, very clear, 165 gallons.	—	1 acre, 2 roods, 2 perches.	About 2 tons pumped into sludge cart and put on land.	Yes	—	8	8	100	Filter effluents (small district only.
Depth 2ft. 9in., gravel, polarite, and sand.	Intermittent	1 acre	—	Not ascertained, given to farmers.	Yes	—	13	13	100	Filter effluents.
Depth 2ft. 9in., gravel, polarite, and sand.	Intermittent	1½ acres	—	Not ascertained, given to farmers.	Yes	—	8	8	100	Filter effluents.
Depth 2ft. 9in., gravel, polarite, and sand.	Intermittent	1¾ acres	—	Not ascertained, given to farmers.	Yes	4	10	14	71·4	Filter effluents.
Depth 3ft. 6in., gravel, polarite, and sand.	Intermittent, tank effluent, 500 gallons per square yard per 24 hours.	—	2½ acres to be laid out for irrigation.	20 tons (wet), given to farmers.	Yes	— 1	10 2	10 3	100 66·6	Filter effluents. Tank effluents.
26in. deep, polarite, coke breeze, gravel.	Continuous, two used at a time; tank effluent, 31 gallons per square yard per 24 hours.	None	1,086 sq. yds.	1,400 gallons given to farmers.	Yes	8	1	9	11·1	Filter effluents. Sewerage scheme for the main portion of Lathom and Burscough awaiting sanction of L. G. Board.
—	—	—	—	—	—	4 1	3 7	7 8	43 87·5	Irrigation effluents. Filter effluents.
6 polarite filters, 2ft. 10in. deep; 4 clinker filters, about 3ft. deep.	Polarite filters used continuously; others intermittently.	8 acres	12½ acres	About 40 tons, pressed, taken away by farmers.	Yes	4 3 3	– 1 5	4 4 8	– 25 62·5	Tank effluents. Irrigation effluents. Filter effluents. The clinker filters being constructed will be used as bacteria filters—intermittently.
Sand and polarite, 3ft.	Intermittent, tank effluent, 500 gallons per square yard.	2 acres	2 acres	—	Yes	–	4	4	100	Filter effluents. Brinscall sewage is to be treated in future at the Abbey village; the tanks enlarged, and 5½ acres of land laid out.
Polarite gravel and sand, 3ft. 3in. deep.	Intermittent; 540 gallons per square yard ordinary flow; 1,000 gallons excessive flow.	—	15½ acres	100 tons sludge, pressed and sold to farmers.	Yes; till 9.30 p.m., and afterwards sewage stored till morning in tanks.	5 (Mixtures of filter effluent and sand wash.)	20	25	80	Filter effluents.

RIBBLE JOINT COMMITTEE—*continued*.

PARTICULARS as to the Method of Sewage Treatment adopted by Local Authorities in the Ribble Watershe

NAME OF AUTHORITY.	Population.	Number of Houses connected with Sewers.	Average Daily Flow of Sewage (per 24 Hours) in Gallons.	Number of Firms turning Trade Waste into Sewers, and the Character of Same.	Number of Precipitation Tanks and Total Capacity in Gallons.	Precipitants used.	Quantity of Precipitants used per Week.	Number of Artificial Filters and Total Area of Same.
1.	2.	3.	4.	5.	6.	7.	8.	9.
PRECIPITATION AND ARTIFICIAL FILTRATION—*continued*.								
CHEMICAL PRECIPITATION AND RAPID MECHANICAL, OR MECHANICO-BIOLOGICAL FILTRATION—*continued*.								
DOMESTIC SEWAGE ONLY—*cont*.								
Oswaldtwistle Urban District Council -	15,000	3,240	300,000		5 tanks; capacity, 1,144,600.	Alumino-ferric - -	2 tons - - -	5 filters, 500 square yard three more to be p down equal to 762 squa yards.
Brierfield Urban District Council - -	8,000	1,800	150,000	—	4 tanks; capacity, 180,000	Alumino-ferric and sulphuric acid to make neutral.	18 cwts. alumino-ferric, and 14 carboys of acid.	4 clarifiers, 150 squa yards filters.
SEWAGE MIXED WITH TRADE WASTE.								
Darwen Corporation - - - - - -	38,000	3,800	750,000	1	6 tanks; 859,572 - -	Ferrozone and alumino-ferric.	47 cwts. - - -	12 filters, 1,568 square yar
Adlington Urban District Council - -	4,600	935	100,000	2 brewers.	4 tanks; 105,000 - -	Ferrozone - - -	16 cwts. - - -	4 filters, 160 square yar
Chorley Rural District Council:								
(Heath Charnock District) - -	1,100	83	500	—	—	- - - The sewers are connected to those of the Urban Dist		
(Anderton District) - - - -	500	106	1,000	—	—		Do. - -	- do. - -
Ince-in-Makerfield Urban District Council	22,000	2,671	250,000	3 breweries.	4 tanks; 411,180 - -	Lime, manganese liquor, and copperas.	63 cwts. lime, 35 cwts. copperas, 13 cwts. liquor.	2 filters, 1,400 square yar
CHEMICAL PRECIPITATION AND BIOLOGICAL FILTRATION.								
DOMESTIC SEWAGE ONLY.								
Walton-le-Dale Urban District Council -	11,000	2,000	250,000 to 300,000	—	3 tanks; 900,000 - -	Alumino-ferric - -	7½ cwts. - - -	3 filters. 900 square yar
SEWAGE MIXED WITH TRADE WASTE.								
Horwich Urban District Council - -	15,000	3,100	450,000	2 bleach works -	5 tanks. Area, 5,895 square yards.	Alumino-ferric. Made at works from bauxite and sulphuric acid.	3½ tons - - -	8 filters. 1,400 squa yards.
SUBSIDENCE OR SEPTIC TREATMENT AND BIOLOGICAL FILTRATION.								
DOMESTIC SEWAGE ONLY.								
Burnley Rural District Council (Altham)	510	330	10,000	—	2 covered septic tanks. Capacity, 6,037.	—	—	4 bacteria filters. Are 110 square yards.
SEWAGE AND TRADES WASTE.								
Accrington and Church Joint Board -	Accrington, about 43,000; Church, about 7,000.	Accrington, all except Baxenden; Church, 1,426.	1,225,000	Don't know -	6 tanks. Capacity, 1,900,000.	Half-ton of lime per day, used as open septic tanks. Lime added to preserve alkalinity of sewage	—	Works are in process Whittaker & Brya down, and at pres receiving treatment.
PRECIPITATION AND LAND FILTRATION.								
DOMESTIC SEWAGE ONLY.								
Barrowford Urban District Council - -	5,500	728	44,000	—	2 tanks. 87,529 - -	Alumino-ferric - -	5 cwts. - - -	—
Chorley Corporation (Heapey District) -	230	46	8,350	—	2 tanks. 11,137 - -	Ferral - - -	1 cwt. 6 lbs. - -	—
Rishton Urban District Council - -	8,000	1,460 (50 unconnected—mostly farm-houses.)	147,000	—	3 tanks - - - -	Alumino-ferric and lime.	1 ton - - -	—
Trawden Urban District Council - -	2,721	316	31,000	—	2 circular tanks. 21,000	Alumino-ferric - -	2 cwts. - - -	—

RIBBLE JOINT COMMITTEE—*continued.*

Columns 2 to 15 inclusive being replies from Local Authorities to queries put by the Joint Committee—*continued.*

Depth and Character of Filtering Materials. 10.	Method of using Filters (whether Intermittent or Continuous), the Character of Liquid put on, and Volume dealt with per Square Yard of Filter per 24 Hours. 11.	Area of Land used for Filtration or Irrigation. 12.	Area of Land owned but not used for Irrigation Purposes. 13.	Amount of Sludge Produced per Week, and how Disposed of. 14.	Is the Day Treatment continued during the Night? 15.	Number of Samples Above Limit. 16.	Number of Samples Below Limit. 17.	Total Samples. 18.	Percentage of Samples Below Limit. 19.	REMARKS. 20.
500 yards polarite 762 yards coke.	Intermittent; tank effluent 300 gallons per square yard.	8 acres - -	4 acres; tanks, artificial filters, and reserve.	80 tons, wet, per week.	Yes - -	3 –	5 8	8 8	62·5 100·	Irrigation effluents. Filter effluents.
3 feet coke and ashes and granite chippings; graded sand in clarifiers.	Intermittent; beds work five minutes and rest 15 minutes; automatic syphonic arrangements, 1,000 gallons per square yard.	1,000 square yards -	2 or 3 acres	15 tons pressed sludge, carted on land by farmers.	Yes - - -	4 10 2	— — —	4 10 2	— — —	Tank effluents. Filter effluents. Thermal filter effluents.
7 filters, polarite, sand, gravel and shingle, 2ft. 11in. deep; 5 filters, coke, sand, gravel, and shingle, 3ft. 2in. deep.	Intermittent; polarite filters, 24 hours in operation, then 24 hours rest. Coke filters 12 hours work and 12 hours rest for aeration, washing 300 to 600 gallons.	3,350 square yards (used for sand washing water only).	26 acres; only 15 suitable for irrigation.	170 tons wet sludge stored in lagoons.	Yes -	6 2	8 —	14 2	57 —	Filter effluents. Tank effluents. The earth beds on which the water used for washing the filters is treated do not give a satisfactory effluent; improvements to be made.
3ft. deep, stones, polarite, sand and gravel.	Intermittent; sometimes continuous; liquid good.	About 2½ acres -	About 1½ acres -	5 tons, disposed of to farmers.	Yes - - -	3	11	14	78·5	Filter effluents
Council of Adlington, who undertake the treatment of the sewage			—	—	—	—	—	—	—	No samples.
- - Do.	- - Do.	- - Do.	—	—	—	—	—	—	—	No samples.
2ft. deep, ashes and clinkers.	Intermittent - -	None at present; land not suitable.	About 14 acres	12 to 15 tons, dried; to farmers.	Yes - - -	5 3	9 8	14 11	64·3 72·5	Tank effluents. Filter effluents. Sewage from 1,200 houses in Ince is treated by the Wigan and Hindley authorities.
3 ft. graded ashes -	Intermittent. 277 gallons per square yard.	—	Works set out within an area of 4 acres.	Not accurately ascertained. Carted away by farmers.	Treated until 12 midnight with alumino - ferric. Remaining night sewage passed into same tanks.	1 5	— 11	1 16	— 68·75	Tank effluents. Filter effluents.
Coke breeze and ashes, 4 ft. 6 in. deep.	Intermittent, liquid slightly coloured, kept in filters 3 or 4 hours.	—	3 acres, 2 roods, 22 yards.	15 tons. Taken to Council's farm.	Yes. Sewage stored in tanks. Filters run off.	9 1	0 5	9 6	— 83	Tank effluents. Filter effluents.
Graded coke, 3 ft. deep.	Intermittent. Tank effluent, 55 gallons.	—	—	In operation 8 months. No sludge.	Yes - - -	—	6	6	100	Filter effluents. Septic treatment.
construction, additional filters on Messrs. inciple (Thermal Aerobic) are now being laid ly a portion of sewage (about one-third) is		—	—	Septic tanks. Small amount of sludge only. We have sludge presses.	Yes. As much as filters will deal with.	8 7 2	— 1	 8 7	— 12·5 71·5	Tank effluents. Ordinary coke filter effluents. Thermal Aerobic filter effluents. Six large Thermal Aerobic filters are being constructed, so that all the sewage may be dealt with.
—		3 acres - - -	5 acres - -	—	Yes - - -	1	6	7	85·5	Irrigation effluents. All house drains not yet coupled up to sewers.
—	—	2,174 square yards -	362 square yards -	15 cwt. Carted on land.	Yes - - -	—	2	2	100	Irrigation effluents. Portion of Chorley Borough (small district).
—	—	5½ acres - - -	½ acre - -	22½ tons pressed sludge. Given to farmers.	Yes - - -	6	5	1	45·5	Irrigation effluents.
—	—	3½ acres - - -	3 acres - - -	About 1½ tons wet. Given to farmers.	Yes -	—	12	12	100	Irrigation effluents. All house drains not yet coupled to sewers.

RIBBLE JOINT COMMITTEE—*continued.*

PARTICULARS as to the methods of Sewage Treatment adopted by Local Authorities in the Ribble Watershed

NAME OF AUTHORITY.	Population.	Number of Houses connected with Sewers.	Average Daily Flow of Sewage (per 24 Hours) in Gallons.	Number of Firms turning Trade Waste into Sewers, and the Character of Same.	Number of Precipitation Tanks and Total Capacity in Gallons.	Precipitants used.	Quantity of Precipitants used per Week.	Number of Artificial Filters and Total Area of Same.
1.	2.	3.	4.	5.	6.	7.	8.	9.
PRECIPITATION AND LAND FILTRATION—*continued.*								
DOMESTIC SEWAGE ONLY—*contd.*								
Padiham Urban District Council	13,500	2,200	240,000	—	6 tanks. 360,000	Copperas, lime and alumino-ferric.	—	—
Clitheroe Rural District Council (Barrow District).	270	75	7,200	—	2 tanks. 10,900	Alumino-ferric	22 lbs.	—
Burnley Rural District Council (Briercliffe District).	2,255	270	25,000	—	—	Sewage passed into Burnley Corporation Sewer and treated		
Burnley Rural District Council (Hapton District).	1,737	239	23,900	—	—	Sewage will shortly be passed into the Burnley Corporation Sewer		
Burnley Rural District Council (Read District).	990	168	19,800	—	—	Sewage passed into the Burnley Corporation Sewer and treated		
Burnley Rural District Council (Simonstone District).	516 Scattered.	31	3,100	—	—	Sewage passed into the Burnley Corporation Sewer and treated		
Chorley Rural District Council (Euxton District).	1,200	80	500	—	2 tanks	Alumino-ferric	—	—
Chorley Rural District Council (Eccleston District).	1,000	100	600	—	2 tanks, 7,500	Alumino-ferric	—	—
Preston Rural District Council (Grimsargh)	432	—	—	—	—	—	—	—
SEWAGE AND TRADE WASTE.								
Chorley Borough (Botany Bay District)	950	211	45,800	1 chemical works. 10,000 gallons daily.	2 tanks 17,230	Ferral	2 cwts.	—
Blackburn Corporation	130,000	25,000	5,000,000	Several breweries	16 tanks, 3,000,000	Alumino-ferric, ferrozone, ferral, copperas, or lime.	15 tons	2 experimental bacteria filters, 1,066 sq. yds.
Wigan Corporation	66,000	12,000	1,750,000	Some breweries	1 tank, 140,000. Extra tanks proposed, to hold 1,500,000.	Lime and copperas	15 grains lime, 5 grains copperas, per gallon.	7 filters, 11 acres
Clayton-le-Moors and Great Harwood Joint Board.	Clayton 9,000 Harwood 12,000	1,800 2,500	800,000	Soap works.	8 tanks, 356,250	Lime and copperas	4 tons 7 cwts. lime, 3 tons 6 cwts. copperas.	—
Colne Corporation	25,000	5,000	500,000	2 tanneries	8 tanks, 221,000	Lime and copperas	3 tons lime, 24 cwts. copperas.	None
SUBSIDENCE AND LAND FILTRATION.								
DOMESTIC SEWAGE ONLY.								
Skelmersdale Urban District Council	5,500	1,000	Not taken	—	—	Lime only	No record kept	
Burnley Rural District Council (Sabden)	560	109	11,200	—	Small detritus chambers		—	—
Leyland Urban District Council	6,800	1,216	91,000	—	2 settling tanks, 33,000	—	—	2 filters, area 36 sq. yds.
Blackburn Rural District Council:								
Clayton-le Dale District	284	114	—	—	2 tanks	—	—	6 filters
Ramsgreave District	239							
Salesbury District	193							
Wilpshire District	413							
SEWAGE AND TRADE REFUSE.								
Clitheroe Corporation	11,000	1,745	500,000	2 breweries	—	A little alumino-ferric occasionally.	About 2 cwts.	—
Pemberton Urban District Council	21,000	4,000	400,000	2 breweries, 2 chemical works.	—	—	—	—
Ormskirk Urban District Council	6,797 in district, 1,300 outside.	1,750	165,000	4 small breweries.	8 tanks, capacity 83,000	None	None	3 coke filters, 735 sq. yds.

RIBBLE JOINT COMMITTEE—*continued.*

Columns 2 to 15 inclusive being replies from Local Authorities to queries put by the Joint Committee—*continued.*

Depth and Character of Filtering Materials. 10.	Method of using Filters (whether Intermittent or Continuous), the Character of Liquid put on, and Volume dealt with per Square Yard of Filter per 24 Hours. 11.	Area of Land used for Filtration or Irrigation. 12.	Area of Land owned but not used for Irrigation Purposes. 13.	Amount of Sludge Produced per Week, and how Disposed of. 14.	Is the Day Treatment continued during the Night? 15.	Number of Samples Above Limit. 16.	Number of Samples Below Limit. 17.	Total Samples. 18.	Percentage of Samples below Limit. 19.	Remarks. 20.
—	—	9½ acres	—	5 tons. Given to farmers.	Yes	2	13	15	86·5	Irrigation effluent. Effluent diluted with extraneous ground water. Closets in town mostly on pail system.
—	—	1¼ acres	All used	Very small, about a wheelbarrow full	Yes	4	5	9	55·5	Irrigation effluents (small district).
by them	—	—	—	—	—	—	—	—	—	No samples.
for treatment	—	—	—	—	—	—	—	—	—	No samples.
by them	—	—	—	—	—	—	—	—	—	No samples.
by them	—	—	—	—	—	—	—	—	—	No samples.
—	—	½ acre	1¾ acres	Unknown. Given to farmers.	Yes	3	6	9	66·5	Filter effluents.
—	—	1¾ acres	—	Unknown. Given to farmers.	Yes	—	1	1	100	Irrigation effluent.
—	—	—	—	—	—	1	13	14	93	Irrigation effluents.
—	—	5,937 square yards for irrigation.	—	15 cwt. Carted away to land.	Yes	2 1	— 2	2 3	— 66·6	Tank effluents. Irrigation effluents. Portion of Chorley Borough (small).
Coke and coke breeze, 5 feet deep.	Intermittent crude sewage treated biologically in the two filters — first in coarse bed, then in fine beds, 150 gallons per square yard.	500 acres—30 acres recently prepared for downward filtration.	-	260 tons of pressed sludge given to farmers or put on tip.	Yes	7 2 2	1 3 3	8 5 5	12·5 60·0 60·0	Tank effluents. Irrigation effluents. Bacteria filter effluents. Small portion of sewage only treated on biological filters. 5 acres of biological filters to be put down.
Natural bed of sand (underdrained).	Intermittently, clarified tank effluent, 25 gallons per square yard.	370 acres	50 acres	20 tons. Sold to farmers.	Treated during night	1 3	9 1	10 4	90 25	Earth filter effluents. Irrigation effluents. Portions of sewage from Orrell, Ince, Aspull, and Standish, treated at works.
—	—	20 acres	10 acres	45 tons pressed cake. Given to farmers.	Yes	4 9	— 5	4 14	— 35·5	Tank effluents. Irrigation effluents.
—	—	17 acres	7 acres	Pressed and carted away by farmers.	Day treatment continued for 19 hours.	7	11	18	61·0	Irrigation effluents.
—	—	14 acres	4 acres	Given to farmers	Yes	—	15	15	100	Irrigation effluents. Diluted with extraneous ground water.
—	—	About 2 acres	1 acre	Used as manure on beds.	Yes	5	11	16	68·5	Irrigation effluents (small district).
Total depth 18in., broken stone 6in., sharp sand 3in., coke breeze 9in.	Continuous, domestic sewage, 2,416 gallons.	8 acres, 11 additional acres of land to be added.	—	3½ tons. Farmers cart away.	Yes	2	6	8	75·0	Irrigation effluents.
—	—	3½ acres	—	—	—	—	5	5	100	Irrigation effluents. The tank effluent is filtered through sand and coke filters before passing on to land.
—	—	37 acres, broad irrigation.	33 acres. Used occasionally.	37½ tons (wet). Used on land.	Yes	7	10	17	58·75	Irrigation effluents. All house drains not yet coupled to sewers.
—	—	120 acres	12 acres	About 10 tons (wet). Spread on land.	Yes	4	20	24	83	Irrigation effluents. Diluted with extraneous ground water.
Cinders, 3 ft. 6in. deep	Alternately for final treatment.	30 acres	42 acres	—	Yes, as a general rule.	6	4 9	10 10	40 10	Irrigation effluents. Filter effluents.

RIBBLE JOINT COMMITTEE—*continued.*

PARTICULARS as to the methods of Sewage Treatment adopted by Local Authorities in the Ribble Watersh

NAME OF AUTHORITY.	Population.	Number of Houses connected with Sewers.	Average Daily Flow of Sewage (per 24 Hours) in Gallons.	Number of Firms turning Trade Waste into Sewers, and the Character of Same.	Number of Precipitation Tanks and Total Capacity in Gallons.	Precipitants used.	Quantity of Precipitants used per Week.	Number of Artificial Filters and Total Area of Same.
	2.	3.	4.	5.	6.	7.	8.	9.
BROAD IRRIGATION.								
DOMESTIC SEWAGE ONLY.								
Billinge Urban District Council	4,200	700	—	—	—	—	—	—
Blackrod Urban District Council	2,300	460	25,060	—	—	—	—	—
Clitheroe Rural District Council (Whalley District).	1,025	205	64,800	—	—	—	—	—
Clitheroe Rural District Council (Chatburn District).	750	160	7,200	—	—	—	—	—
Withnell Urban District Council (Brinscall District).	—	—	16,000	—	—	—		—
Blackburn Rural District Council:								
Livesey District	2,733	32	—	—	—	—	—	—
Pleasington District	436	27						
NO SYSTEM OF SEWAGE DISPOSAL.								
Burnley Rural District Council (the Districts of Cliviger, Huncoat, and Wheatley Lane)								
Wigan Rural District Council (the Districts of Shevington, Wrightington, Parbold, Dalton, and Worthington)	—	—	—	—	—	—	—	—
Withnell Urban District Council (portion of)								
Preston Rural District Council (Penwortham).	1,671	—	—	—	—	—	—	Sewerage works i
Preston Rural District Council (Farington).	2,154							
Fulwood Urban District Council	5,000	All	150,000	None	—	—	—	—
West Lancashire Rural District Council	2,178	-	—	—	—	No sewerage schemes, except at Bickerstaffe, where a few houses (33		
Croston Urban District Council	2,034	—	—	—	—	There are at present no sewerage works within the district.		
Blackburn Rural District Council:								
Mellor District	1,138	No record	—	—	—	—	—	—
Balderstone District	510	—	—	—	—	The sewers are laid, but the disposal works have not been		
Mellor District	1,138							
Eccleshill District	395	—	—	—	—	The sewers are laid, but the disposal works have not been		
Yate and Pickup Bank District	581							
PARTICULARS NOT SUPPLIED.								
Burnley Corporation: Wood End Works	—	—	—	—	—	—	—	—
Burnley Corporation: Altham Works	—	—	—	—	—	—	—	—
Standish Urban District Council	—	—	—	—	—	—	—	—

RIBBLE JOINT COMMITTEE—*continued.*

Columns 2 to 15 being replies from Local Authorities to queries put by the Joint Committee—*continued.*

Depth and Character of Filtering Materials.	Method of using Filters (whether Intermittent or Continuous), the Character of Liquid put on, and Volume dealt with per Square Yard of Filter per 24 Hours.	Area of Land used for Filtration or Irrigation.	Area of Land owned but not used for Irrigation Purposes.	Amount of Sludge Produced per Week, and how Disposed of.	Is the Day Treatment continued during the Night?	Number of Samples Above Limit.	Number of Samples Below Limit.	Total Samples.	Percentage of Samples Below Limit.	Remarks.
10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
—	—	15 acres - - -	—	—	Yes - - -	—	2	2	100	Irrigation effluents.
Land filtration - -	—	100 acres - -	—	—	Yes - - -	—	4	4	100	Irrigation effluents.
—	—	3 acres - - -	All used - -	2 cartloads. Put on land.	Yes - - -	1	10	11	91	Irrigation effluents (small district).
—	—	2 acres - - -	All used - -	1 cartload. Put on land.	Yes - - -	—	4	4	100	Irrigation effluents (small district).
—	—	5 acres - - -	Whole system under reconstruction.	—	Yes - - -	7	8	15	53	Irrigation effluents (portion of Withnell Urban District Council).
—	—	8 acres - -	½ acre - - -	—	—	—	1	1	100	Irrigation effluent.
—	—	—	-	-	—	—	--	—	—	All small districts.
course of construction	—	—	—	—	—	—	—	—	—	No works at present. No samples.
—	—	—	-	—	—	—	—	—	—	Scheme in hand. No samples.
are connected to the Ormskirk Urban District Council sewers			—	--	—	—	—	—	—	No samples.
Works of this nature are, however, about to be commenced			—	—	—	—	—	—	—	No samples.
—	—	—	—	—	—	—	—	—	—	No samples.
commenced, and no connections have yet been made			—	—	—	—	—	—	—	No samples.
commenced, and no connections have yet been made			--	—	—	—	—	—	—	No samples.
—	—	—	—	—	—	8	—	8	—	Tank effluents.
						7	12	19	63	Irrigation effluents.
						5	1	6	17	Biological filter effluents, passed through coarse filter only.
						—	3	3	100	Biological filter effluents, passed through coarse and fine filters.
—	—	—	—	—	—	8	5	13	38	Irrigation effluents.
—	—	—	—	—	—	4	16	20	80	Filter effluents.
						3	—	3	--	Irrigation effluents.

Appendix 5.

RIBBLE JOINT COMMITTEE—*continued.*

SUMMARY OF RESULTS OF DIFFERENT METHODS OF TREATMENT.

Number of Authorities.	Number of Sewage Works or Districts.	METHOD OF TREATMENT.	Number of Samples Above Limit.	Number of Samples Below Limit.	Total Number of Samples.	Percentage of Samples Below Limit.
		PRECIPITATION ONLY.				
1	1	(A) DOMESTIC SEWAGE ONLY - - -	2	2	4	50
—	—	(B) SEWAGE MIXED WITH TRADE WASTE	None	None	None	None
		CHEMICAL PRECIPITATION AND RAPID MECHANICAL, OR MECHANICO-BIOLOGICAL, FILTRATION.				
11	13	(C) DOMESTIC SEWAGE ONLY - -	61	113	174	65
4	3	(D) SEWAGE MIXED WITH TRADE WASTE	19	36	55	65·5
		CHEMICAL PRECIPITATION AND BIOLOGICAL FILTRATION.				
1	1	(C′) DOMESTIC SEWAGE ONLY - - -	6	11	17	64·5
1	1	(D′) SEWAGE MIXED WITH TRADE WASTE	10	5	15	33·3
		SUBSIDENCE OR SEPTIC TREATMENT AND BIOLOGICAL FILTRATION.				
1	1	(E) DOMESTIC SEWAGE ONLY - -	—	6	6	100
2	1	(F) SEWAGE MIXED WITH TRADE WASTE	17	6	23	26
		PRECIPITATION AND LAND FILTRATION.				
9	11	(G) DOMESTIC SEWAGE ONLY - - -	17	63	80	79
6	5	(H) SEWAGE MIXED WITH TRADE WASTE	38	35	73	48
		SUBSIDENCE AND LAND FILTRATION.				
4	4	(I) DOMESTIC SEWAGE ONLY - - -	7	37	44	84
3	3	(J) SEWAGE MIXED WITH TRADE WASTE	18	43	61	70
		BROAD IRRIGATION.				
5	6	(K) DOMESTIC SEWAGE ONLY - - -	8	29	37	78
—	—	(L) SEWAGE MIXED WITH TRADE WASTE	None	None	None	None
8	17 (All small except one.)	NO SYSTEM OF SEWAGE DISPOSAL.				
2	3	PARTICULARS NOT SUPPLIED:				
		BURNLEY CORPORATION, WOOD END WORKS.	20	16	36	44
		BURNLEY CORPORATION, ALTHAM WORKS.	8	5	13	38
		STANDISH URBAN DISTRICT COUNCIL	7	16	23	70

NOTE.—Certain Authorities have two or more Outfall Works classified under different headings.

W. NAYLOR, F.C.S., A.M.I.C.E.,
Chief Inspector.

APPENDIX No. 6.

Handed in by Mr. F. Scudder, F.C.S., F.I.C.

ANALYSES OF SAMPLES OF SEWAGE EFFLUENTS FROM SANITARY AUTHORITIES IN THE MERSEY AND IRWELL WATERSHED.

Appendix 6.

APPENDIX No. 6.

Table A.

ANALYSES OF SAMPLES OF SEWAGE

No.	Authority.	State of Weather.	Date. 1900.	Time.	Method of Purification.	Remarks on Sample as received.
1	Little Lever U.D.C.	Showery	23 Aug.	2.20 p.m.	Tanks and filters	Clear, colourless. No smell
2	Crompton U.D.C.	Fine	12 Sept.	12 noon	Tank and filter	Clear, colourless. No smell
3	Cheadle and Gatley U.D.C.	Dry	15 Aug.	12.30 p.m.	Tanks and filters	Clear, colourless. No smell
4	Westhoughton U.D.C. (Marsh Brook).	Fine	28 Aug.	11.30 a.m.	Land treatment	Clear, colourless, trace of brown sediment. No smell.
5	Hayfield R.D.C.	Dry	10 Sept.	1.30 p.m.	Tanks and land	Faint brown colour, trace of brown sediment. Very faint smell.
6	Romiley U.D.C.	Dry	13 Sept.	11 a.m.	Bacteria beds	Clear, colourless. No smell
7	Hollingworth U.D.C.	Dry	6 Sept.	2.30 p.m.	Tanks and filters	Faint brown colour, traces of brown sediment. No smell.
8	Littleborough U.D.C.	Fine	10 Sept.	2.15 p.m.	Tanks and filters	Clear, colourless. No smell
9	Ashton - on - Mersey U.D.C.	Dry	29 Aug.	2 p.m.	Tanks and land	Clear, colourless, trace of brown sediment. No smell.
10	Wilmslow U.D.C. (Northern Outfall).	Showery	23 Aug.	10 a.m.	Tanks and land	Slightly turbid, no sediment. Faint soapy
11	Bucklow (Timperley) R.D.C.	Dry	17 Sept.	1 p.m.	Tanks and filters	Slightly turbid, brown sediment. No smell
12	Mossley Corporation	—	20 Sept.	2.50 p.m.	Tanks and filters	Light brown, with brown sediment. Faint earthy smell.
13	Hindley U.D.C. (Hindley Green).	Hot, dry	16 Aug.	3.15 p.m.	Tanks and filters	Clear, trace of sediment. No smell
14	Chapel-le-Frith R.D.C.	Dry	12 Sept.	1 p.m.	Tanks and land	Clear, colourless. No smell
15	Disley R.D.C.	Dry	10 Sept.	4.30 p.m.	Tanks and land	Faintly turbid, no sediment. Soapy smell
16	Abram U.D.C.	Fine	13 Sept.	4.30 p.m.	Bacteria beds	Clear, colourless, traces of sediment. No smell
17	Lymm U.D.C.	Dry	1 Aug.	2.30 p.m.	Tanks and willow beds.	Brown, with brown sediment. No smell
18	Bowdon U.D.C.	Dry	29 Aug.	12.30 p.m.	Tanks and land	Clear, colourless, traces of brown sediment. No smell.
19	Royton U.D.C.	Fine	12 Sept.	11 a.m.	Tanks and filters	Clear, little brown flocculent sediment. No smell.
20	Ashton - in - Makerfield U.D.C.	Hot, dry	16 Aug.	12.45 p.m.	Tanks and land	Clear, trace of granular sediment. No smell
21	Bucklow R.D.C. (Northenden).	Dry	15 Aug.	1.30 p.m.	Tanks and land	Brown colour, brown sediment. Very faint smell.
22	Bolton Corporation (Rhodes Farm).	Fine	4 Sept.	11.45 a.m.	Tanks and land	Clear, colourless, small amount of brown sediment. Very faint earthy smell.
23	Alderley U.D.C.	Showery	23 Aug.	12 noon	Tanks and land	Slightly turbid, traces of sediment. Faint soapy smell.
24	Wilmslow U.D.C. (South Outfall).	Showery	23 Aug.	11 a.m.	Tanks and land	Clear, colourless. No smell
25	Westhoughton U.D.C. (Rogers Farm).	Fine	28 Aug.	1 p.m.	Tanks, filters, land	Clear, brown sediment. No smell
26	Worsley U.D.C. (Boothstown).	Fine	29 Aug.	2.45 p.m.	Tanks and land	Clear, trace of grey sediment. Faint earthy smell.
27	Macclesfield R.D.C. (Poynton).	Dry	5 Sept.	5 p.m.	Tanks and land	Clear, colourless, some grey sediment. Very faint smell.
28	Oldham Corporation	Fine	5 Sept.	11 a.m.	Tanks and filters	Faint turbidity, little grey sediment. Faint smell.
29	Mottram U.D.C.	Dry	6 Sept.	10.30 a.m.	Tanks	Liquid clear, trace of grey sediment. No smell
30	Failsworth U.D.C.	Fine	5 Sept.	1.45 p.m.	Tanks and filters	Faint turbidity, trace of brown sediment. No smell.
31	Altrincham U.D.C.	Dry	17 Sept.	2 p.m.	Tanks and land	Brown, with brown sediment. Slight earthy smell.
32	Hale No. 2 Outlet	Dry	29 Aug.	11 a.m.	Tanks and land	Almost clear, little brown sediment. No smell
33	Stockport R.D.C. (Offerton).	Dry	13 Sept.	1 p.m.	Tanks and filters	Pink colour, trace of sediment. Faint smell
34	Denton U.D.C.	Fine	30 Aug.	1.45 p.m.	Tanks and filters	Almost clear, no sediment. Very faint smell
35	Kearsley U.D.C.	Hot, dry	14 Aug.	1.10 p.m.	Tanks and filters	Fairly clear, traces of grey sediment. No smell
36	Swinton and Pendlebury U.D.C. (Pendlebury).	Fine	4 Sept.	12.45 p.m.	Tanks and filters	Liquid clear, little grey sediment. Slight earthy smell.
37	Urmston and Flixton J.S.B.	Fine	14 Sept.	9.30 a.m.	Tank effluent	Liquid faintly turbid, trace of dirty sediment. Very faint smell.
38	Stockport Corporation	Dry	15 Aug.	10 a.m.	Tanks and land	Faintly turbid, brown sediment. Faint smell
39	Droylsden U.D.C.	Fine	5 Sept.	3 p.m.	Tanks and filters	Faintly turbid, quantity of brown sediment. Faint smell.
40	Marple U.D.C.	Dry	13 Sept.	12 noon	Tanks and filters	Faintly turbid, trace of sediment. Faint smell
41	Haslingden, Rawtenstall and Bacup S.O.B.	Hot	15 Aug.	1.30 p.m.	Tanks and land	Faintly turbid, little fungus sediment. Slight smell developed.
42	Whitefield U.D.C.	Fine	11 Sept.	12 noon	Tanks and land	Faintly turbid, trace of dark sediment. No smell.
43	Prestwich U.D.C.	Fine	4 Sept.	10.40 a.m.	Tanks and filters	Turbid, little grey sediment. Slight sour smell
44	Tyldesley U.D.C.	Fine	29 Aug.	1.45 p.m.	Tanks and filters	Slightly turbid, trace of sediment. Slight sour smell.
45	Oldham Corporation	Fine	5 Sept.	11.10 a.m.	Tank effluent	Turbid, black sediment. Putrescent smell
46	Salford Corporation	Fine	6 Sept.	12.30 p.m.	Tank effluent	Grey, turbid, traces of grey sediment. Alkaline. Lime effluent smell.
47	Salford Corporation	Showery	22 Aug.	3.10 p.m.	Tank effluent	Grey, turbid, dark sediment. Alkaline. Nitrites present. Tarry smell.
48	Hyde Corporation	Fine	30 Aug.	12.45 p.m.	Tank effluent	Grey, turbid. Putrescent smell
49	Farnworth U.D.C.	Hot, dry	24 July	2.15 p.m.	Tank effluent	Slightly turbid, finely divided sediment. Strongly alkaline. Lime effluent smell.
50	Manchester Corporation	Fine	6 Sept.	2 p.m.	Tank effluent	Brown, turbid, with dark sediment. Strong tarry smell.
51	Manchester Corporation	Fine	21 Aug.	1.30 p.m.	Tank effluent	Brown, turbid, brown sediment. Very strong tarry smell.

September, 1900.

Appendix 6.

APPENDIX No. 6.

Table A.

EFFLUENTS FROM SANITARY AUTHORITIES.

Chemical Results, expressed in Grains per Gallon.											
Ammonias.		Oxygen Absorbed.		Chlorides as (Cl.).	Nitrates and Nitrites.	Dissolved Oxygen Test.					
						Oxygen at Start.	Oxygen after 24 hours.	Oxygen after 48 hours.	C.C.'s dissolved Oxygen consumed per Litre.	Nitrites formed during Incubation.	
Free.	Albuminoid.	3 minutes.	4 hours.							After 24 hours.	After 48 hours.
0·173	0·044	0·08	0·09	7·5	1·21	—	—	—	—	—	—
0·28	0·022	0·08	0·16	2·3	0·39	6·8	6·2	5·8	1·0	None	None.
0·42	0·022	0·10	0·27	3·1	0·30	6·5	6·4	6·2	0·3	None	None.
0·31	0·038	0·13	0·31	3·5	0·12	7·8	7·0	7·0	0·8	None	None.
0·42	0·042	0·15	0·32	3·0	0·11	6·8	6·6	5·4	1·4	None	None.
0·45	0·054	0·16	0·32	4·5	0·44	6·4	6·4	5·8	0·6	Faint	None.
0·77	0·067	0·13	0·33	3·5	0·10	6·6	5·7	5·6	1·0	None	None.
0·98	0·073	0·18	0·34	4·8	0·03	6·8	6·0	5·2	1·6	None	None.
0·45	0·039	0·17	0·35	4·1	0·14	7·7	7·4	6·6	1·1	None	None.
0·59	0·033	0·19	0·38	3·5	0·10	7·0	6·9	6·7	0·3	None	None.
0·63	0·084	0·16	0·38	—	0·04	6·7	5·6	5·4	1·3	None	None.
1·12	0·096	0·14	0·38	—	—	6·5	6·0	5·7	0·8	None	None.
0·59	0·050	0·17	0·42	4·8	0·80	6·5	—	5·5	1·0	None	None.
0·70	0·074	0·18	0·42	2·7	0·05	6·3	6·0	5·9	0·4	Trace	None.
1·12	0·096	0·40	0·52	3·8	0·04	6·5	6·1	5·0	1·5	None	Trace.
0·63	0·049	0·31	0·52	—	0·60	6·5	6·1	5·9	0·6	None	Trace.
0·65	0·050	0·11	0·54	5·7	0·02	5·6	5·4	4·7	0·9	None	None.
0·77	0·050	0·22	0·54	3·4	0·07	7·2	7·0	6·6	0·6	None	None.
1·82	0·095	0·23	0·55	4·3	0·03	6·8	5·4	4·4	2·4	None	None.
0·03	0·033	0·20	0·61	3·2	0·11	6·6	—	6·2	0·4	—	None.
0·74	0·077	0·27	0·69	3·8	0·14	6·4	5·8	5·6	0·8	None	None.
0·63	0·047	0·38	0·69	6·5	0·23	6·5	6·3	5·9	0·6	None	None.
0·50	0·042	0·19	0·70	3·1	0·11	7·2	6·0	5·6	1·6	None	None.
0·03	0·028	0·24	0·71	2·5	0·14	7·3	7·1	7·0	0·3	None	None.
0·56	0·087	0·26	0·74	5·9	0·28	7·7	7·0	7·0	0·7	None	Trace.
1·61	0·099	0·27	0·74	7·3	0·11	7·3	6·3	5·0	2·3	None	None.
0·56	0·067	0·20	0·74	3·5	0·03	6·5	6·1	5·9	0·6	None	None.
0·98	0·151	0·43	0·80	6·0	0·05	6·8	5·7	4·7	2·1	None	Present.
0·42	0·095	0·25	0·82	2·5	0·22	6·5	5·6	5·5	1·0	None	None.
0·79	0·120	0·36	0·84	5·9	1·82	6·5	5·6	4·7	1·8	None	Present.
0·77	0·088	0·34	0·84	—	0·13	6·7	6·2	5·5	1·2	None	None.
1·08	0·120	0·37	0·92	3·9	0·41	7·7	7·0	5·9	1·8	Present	None.
1·15	0·157	0·46	0·93	5·6	0·18	5·8	5·1	4·6	1·2	Trace	None.
0·66	0·095	0·29	0·94	5·7	0·25	7·4	7·2	—	—	None	—
1·40	0·103	0·39	0·95	8·8	0·18	6·4	5·4	4·5	1·9	Trace	None.
1·89	0·196	0·50	1·01	8·6	0·06	6·1	3·5	2·0	4·1	None	None.
0·77	0·141	0·47	1·09	5·2	0·10	6·3	5·1	3·8	2·5	None	None.
1·01	0·168	0·42	1·10	7·1	0·14	6·4	4·9	4·1	2·3	None	None.
1·40	0·159	0·71	1·33	11·2	0·03	8·1	6·5	4·8	3·3	None	None.
3·15	0·227	0·55	1·34	7·5	0·04	6·0	3·0	0·9	5·1	None	None.
1·68	0·238	0·83	1·37	3·4	0·11	6·3	4·3	2·2	4·1	None	None.
0·77	0·120	0·57	1·53	4·3	0·64	6·8	4·6	3·4	3·4	Trace	Trace.
1·62	0·182	0·79	1·78	4·6	0·05	6·1	1·4	0·0	6·1 +	None	None.
3·01	0·197	0·84	2·40	10·2	0·08	7·6	1·5	0·0	7·6 +	None	None.
2·38	0·291	1·22	2·82	5·0	0·02	6·5	1·8	0·0	6·5 +	None	None.
1·82	0·322	1·30	3·52	8·1	0·02	7·1	0·0	0·0	7·1 +	Trace	None.
0·91	0·238	1·81	4·12	4·9	0·25	7·3	2·9	0·0	7·3 +	Trace	Trace.
4·06	0·655	1·48	4·74	27·2	0·00	7·4	0·0	0·0	7·4 +	None	None.
1·17	0·274	1·02	4·83	9·2	0·08	7·4	0·1	0·0	7·4 +	None	None.
2·45	0·456	3·97	7·24	12·1	0·00	7·1	0·0	0·0	7·1 +	None	None.
2·10	0·285	4·6	9·19	13·6	0·04	7·7	5·3	2·4	5·3	None	None.

Frank Scudder, F.I.C.

Appendix 6.

TABLE B.

ANALYSES OF SAMPLES OF SEWAGE

No.	Authority.	Date.	Time.	Method of Purification.	Remarks on Sample as received.	Ammonias.		Oxygen absorbed.	
						Free.	Albuminoid.	Three minutes.	Four hours.
		1900:							
1	Whitworth U.D.C. - -	18 July -	1.45 p.m. .	Tanks and filters -	Clear, colourless. No sediment. No smell.	0·43	0·056	0·076	0·34
2	Barton R.D.C., Clifton -	13 „ -	11.5 a.m. -	Tanks and filters -	Brown, brown sediment. No smell	0·31	0·067	0·36	0·43
3	Little Lever U.D.C. - -	10 „ -	1 p.m. -	Filtered - - -	Almost colourless, light brown and dark sediment. No smell.	1·07	0·095	0·277	0·45
4	Littleborough U.D.C. -	11 „ -	1.30 p.m. -	Precipitation and filtration.	Almost colourless, traces of brown sediment. No smell.	0·70	0·112	0·26	0·57
5	Crompton U.D.C., Newhey	11 „ -	10.45 a.m.	Precipitation and filtration.	Almost colourless, traces of brown sediment. No smell.	1·05	0·119	0·27	0·60
6	Tottington U.D.C. - -	13 „ -	10.30 a.m.	Tanks and land -	Turbid, brown sediment. No smell	1·89	0·075	0·43	0·66
7	Westhoughton U.D.C., Rogers' Farm.	12 „ -	3 p.m. -	Tanks, filters and land.	Liquid faintly brown, some dark brown flocculent sediment. No smell.	0·54	0·061	0·33	0·71
8	Radcliffe U.D.C. - -	9 „ -	4.50 p.m. -	Tanks and filters -	Almost colourless, small amount of sediment. No smell.	0·378	0·077	0·24	0·72
9	Swinton and Pendlebury U.D.C., Pendlebury.	4 „ -	12.15 p.m.	Tanks and filters -	Light brown, brown sediment. Faint smell.	1·82	0·154	0·33	0·79
10	Macclesfield Corporation -	19 „ -	—	—	Slightly turbid, trace of sediment. Slight smell.	0·41	0·095	0·34	0·85
11	Turton U.D.C., Eagley -	10 „ -	4 p.m. -	Filtered - - -	Slightly turbid, brown sediment. Faint smell.	1·61	0·210	0·43	0·86
12	Swinton and Pendlebury U.D.C., Pendlebury.	13 „ -	10.30 a.m.	Tanks and filters -	Slightly turbid, light brown sediment. Faint smell.	1·54	0·120	0·53	1·02
13	Turton U.D.C. - - -	9 „ -	1.30 p.m. -	Tanks and filters -	Turbid, light brown sediment. Sewage smell.	2·80	0·240	0·41	1·05
14	Stockport R.D.C., Offerton	19 „ -	—	—	Clear liquid coloured with eosine, trace of grey sediment. Slight sewage smell.	1·19	0·114	0·41	1·12
15	Hale U.D.C. - . -	18 „ -	—	—	Slightly turbid, no sediment. Sewage smell.	1·54	0·185	0·40	1·14
16	Gorton U.D.C. - - -	12 „ -	11.40 a.m.	Tank effluent - -	Liquid turbid, faint grey sediment. Faint smell.	1·96	0·145	0·52	1·19
17	Hindley U.D.C., Platt Bridge.	12 „ -	2 p.m. -	Tanks and land -	Slightly turbid, no sediment. Slight putrescent smell.	1·69	0·119	0·50	1·20
18	Withington U.D.C. - -	10 „ -	4.45 p.m. -	Land - - -	Turbid, dark sediment. Strong earthy smell.	1·75	0·154	0·74	1·35
19	Haslingden, Rawtenstall, and Bacup J.O.B.	13 „ -	1.15 p.m. -	Tanks and land. No precipitation.	Light brown, turbid, finely divided grey sediment. No smell.	0·42	0·201	0·60	1·38
20	Knutsford U.D.C. - -	17 „ .	—	—	Slightly turbid, small quantity of grey sediment. Slight smell.	4·20	0·249	0·58	1·48
21	Tyldesley U.D.C. - -	12 „ -	11.15 a.m.	Tanks and filters -	Slightly turbid, no sediment. Faint sour smell.	3·44	0·154	0·79	1·50
22	Rochdale Corporation, Sudden Valley Outlet.	12 „ -	2 p.m. -	Tank effluent - -	Fairly clear, little grey sediment. Faint sour smell.	1·71	0·259	0·62	1·68
23	Failsworth U.D.C. - -	13 „ -	7.30 p.m. -	Treated effluent -	Turbid, light brown sediment. Slight smell.	3·01	0·154	0·72	1·71
24	Tottington U.D.C. - -	17 „ -	12.15 p.m.	Tanks and land -	Turbid, with dark brown sediment. Slight putrescent smell.	0·91	0·095	0·76	1·80
25	Withington U.D.C. - -	10 „ -	4.15 p.m. -	Land - - -	Dark, turbid, dark sediment. Putrescent smell.	2·45	0·294	1·02	1·85
26	Marple U.D.C. - - -	19 „ -	—	—	Slightly turbid, trace grey sediment. Faint earthy smell.	2·52	0·316	0·73	1·94
27	Prestwich U.D.C. - -	10 „ -	4·30 p.m. -	Part filtered - -	Turbid, dark sediment. Sewage smell.	2·03	0·280	1·00	2·06
28	Prestwich U.D.C. - -	4 „ -	10.45 a.m.	Part filtered - -	Turbid, black sediment. Putrescent smell.	1·84	0·476	0·87	2·23
29	Swinton and Pendlebury U.D.C., Swinton.	13 „ -	11.45 a.m.	Tanks, land and cinder.	Light brown, dark brown sediment. Faint putrescent smell.	1·47	0·201	1·04	2·71
30	Norden U.D.C. - - -	18 „ -	10.45 a.m.	Tanks and filters -	Slightly turbid, trace of sediment. Sewage smell.	6·58	0·442	1·34	2·91
31	Oldham Corporation - -	11 „ -	3.40 p.m. -	Tank effluent - -	Dirty brown, black sediment. Sewage smell.	3·29	0·378	1·24	3·22
32	Rochdale Corporation, Roach Mills Outlet.	12 „ -	1.50 p.m. -	Tank effluent - -	Liquid clear, little grey flocculent sediment. Sour smell.	3·32	0·324	1·69	3·43
33	Droylesden U.D.C. - -	14 „ -	8.30 a.m. -	Tank effluent - -	Brown, with quantity of brown sediment. Faint smell.	1·61	0·198	1·16	4·40
34	Bolton Corporation, Hacken	10 „ -	12.15 p.m.	Tank effluent - -	Dark brown, very turbid, dark sediment. Tarry smell.	3·29	0·523	3·03	6·92
35	Whitefield U.D.C. - -	17 „ -	10.10 a.m.	Tanks and land -	Turbid, brown sediment. No smell.	1·75	0·168	0·56	1·72
36	Altrincham U.D.C. - -	18 „ -	—	—	Clear brown colour, trace of sediment.	1·12	0·148	0·60	1·58

September 1900.

Appendix 6.

TABLE B.

EFFLUENTS FROM SANITARY AUTHORITIES.

Chlorides as Chlorine.	Nitrites and Nitrates.	Dissolved Oxygen test.			c.c.'s of dissolved Oxygen consumed per litre.	Nitrites in dissolved Oxygen sample.		After five days in the Incubator.		
		At start.	After 24 hours.	After 48 hours.		After 24 hours.	After 48 hours.	Oxygen absorbed. Three minutes.	Oxygen absorbed. Four hours.	Remarks.
4·0	7·58	6·7	5·9	5·2	1·5	none	none	0·07	0·32	Clear, colourless, trace of sediment. No smell.
6·2	0·70	6·6	5·8	5·2	1·4	none	none	0·28	0·48	Clear, colourless, trace of brown sediment. No smell
7·6	0·05	6·9	6·8	5·3	1·6	none	none	0·07	0·33	Clear, colourless, traces of sediment. No smell.
3·5	0·16	6·5	5·4	5·0	1·5	none	none	0·16	0·43	Colourless, traces of sediment. Slight smell.
4·6	0·06	6·3	5·8	5·0	1·3	none	none	0·11	0·28	Colourless, light brown sediment. Slight smell.
4·4	0·65	6·6	5·2	4·4	2·2	none	none	0·26	0·35	Clear, little sediment. Faint musty smell.
6·4	0·04	7·0	6·0	5·5	1·5	very faint trace.	present	0·19	0·65	Light brown, brown flocculent sediment. No smell.
5·6	—	6·5	6·4	5·0	1·5	none	none	0·12	0·50	Almost colourless, trace of sediment. No smell.
6·9	—	6·6	6·5	5 8	0·8	trace	trace	0·27	0·57	Clear, colourless, brown sediment. No smell.
3·7	0·02	6·5	4·9	4·2	2·3	none	none	0·61	1 16	Dark, with black sediment. Putrescent and sulphuretted hydrogen smell.
3·6	0·01	7·2	4·6	2·7	4·5	none	none	0·72	1·12	Slightly dark, dark brown sediment. Faint smell of sulphuretted hydrogen gas.
8·7	0·03	6·8	3·8	2·8	4·0	none	faint traces.	0·67	1·31	Dark colour, little dark sediment. Trace of sulphuretted hydrogen gas.
6·4	—	6·5	2·6	0·4	6·1	none	none	1·3	1·55	Black, black sediment. Putrescent. Sulphuretted hydrogen gas.
2·0	0·02	6·4	4·8	3·0	3·4	none	none	0·87	1·41	Fluorescent, brown sediment. Earthy smell.
3·8	0·02	7·0	2·8	1·4	5·6	none	none	1·02	1·60	Black, with black sediment. Slight putrescent and sulphuretted hydrogen gas smell.
6·4	0·02	6·6	3·0	1·1	5·5	none	none	1·50	2·07	Slightly turbid, grey sediment. Slight putrescent and sulphuretted hydrogen gas smell.
9·9	0·03	7·2	5·0	4·4	2·8	none	none	0·76	1·51	Dark, black sediment. Putrescent smell. Faint sulphuretted hydrogen gas.
4·3	0·02	7·6	6·7	5·5	2·1	none	none	0·97	1·58	Dark, dark sediment. Earthy smell.
4·3	0·03	6·6	3·7	1·5	5·1	faint trace.	trace	0·72	1·85	Dark, containing black sediment. Putrescent and sulphuretted hydrogen gas.
7·1	0·13	6·6	2·9	0·3	6·3	none	none	0·78	2·01	Dark, with black sediment. Trace of sulphuretted hydrogen gas.
9·0	0·03	6·9	3·7	1·1	5·8	none	none	1·12	1·85	Dark, dark sediment. Putrescent smell. Sulphuretted hydrogen gas.
4·2	0·07	7·2	4·6	3·3	3·9	none	none	0·55	1·80	Almost colourless, greyish brown sediment. Slight earthy smell.
5·8	0·00	6·7	2·0	0·0	6·7+	none	none	1·64	3·12	Dark, with little dark sediment. Little sulphuretted hydrogen gas.
5·0	0·14	7·0	4·0	1·7	5·3	traces	plentiful	1·04	2·03	Black, black sediment. Putrescent smell. Sulphuretted hydrogen gas.
4·7	0·00	7·1	2·7	0·0	7·1+	none	none	1·83	2·6	Black, black sediment. Putrescent. Sulphuretted hydrogen gas.
6·5	0·03	6·3	1·3	0·2	6·1	none	none	2·25	3·08	Black, black sediment. Putrescent. Sulphuretted hydrogen gas smell.
4·6	0·00	6·0	0·1	0·0	6·0+	none	none	3·08	12·75	Black, black sediment. Putrescent. Sulphuretted hydrogen gas.
3·9	—	6·1	2·7	0·0	6·1+	none	none	2·29	4·1	Black, black sediment. Putrescent. Little sulphuretted hydrogen gas.
10·7	0·00	6·8	1·3	0·0	6·8+	none	none	1·60	3·61	Dark liquid, black sediment. Sulphuretted hydrogen gas.
8·7	0·00	7·0	0·0	0·0	7·0+	none	none	3·77	5·0	Black, with black sediment. Putrescent smell. Sulphuretted hydrogen gas.
6·6	0·00	6·7	0·0	0·0	6·7+	none	none	4·65	6·52	Black, with black sediment. Putrescent. Sulphuretted hydrogen gas.
7·6	0·05	7·2	3·4	0·0	7·2+	none	faint traces.	1·43	2·89	Almost colourless, greyish brown sediment. Trace of sulphuretted hydrogen gas.
9·3	0·00	6·7	2·1	0·0	6·7+	none	none	2·67	14·0	Black, black sediment. Putrescent smell. Sulphuretted hydrogen gas.
11·2	0 00	7·3	0·0	0·0	7·3+	none	none	3·67	6·5	Very dark brown, black sediment. Putrescent lime effluent smell.
5·3	0·68	6·6	4·2	3·0	3·6	strong traces.	abundant	0·36	1·12	Slightly turbid, brown sediment. Slight smell.
7·8	0·56	7·0	6·5	5·1	1·9	none	none	0·41	1·13	Brown, with brown sediment. Faint musty smell.

Frank Scudder F.I.C.

Appendix 7.

APPENDIX No. 7.

Handed in by JOHN C. THRESH, Esq., M.D.

REPORT ON AN OUTBREAK OF TYPHOID FEVER AT SHOEBURYNESS ATTRIBUTED TO EATING COCKLES.

By JOHN C. THRESH, M.D., &c., Medical Officer of Health, Essex County Council, and E. R. WALTER, M.R.C.S., Medical Officer of Health, Shoeburyness.

Shoeburyness is an urban district at the extreme south-east of the county of Essex, bounded on the south by the Thames, on the east by the German Ocean, and on the north and west by the Rochford Rural District, of which until recently it formed a part. Nearly the whole of this area has a high death rate from typhoid fever, and every autumn outbreaks of greater or less intensity occur.

The population of Shoebury at the last census was 2,990, but it is now believed to be over 4,000. This does not include the garrison or school of gunnery which is within the district. It is on the London clay, but this is covered, save along the coast, by beds of post-glacial gravel and sand and by brick earth. The abundance of the latter causes brickmaking to flourish, and a considerable portion of the population is employed in the brickfields. The whole area is fairly flat, but it is well above the sea level.

Until about two years ago the town derived its supply of water from shallow wells, most of which were liable to serious pollution. The present supply is from a deep well piercing the London clay, and yielding a supply of great organic purity. The waterworks were designed by Mr. Mansergh, and the works carried out under the supervision of his firm. They appear to me to be very satisfactory, and except in the outlying portions of the district, the population is now supplied from the works. Many wells have recently been closed.

The town is sewered, but certain of the sewers have little fall, and have no automatic flushing arrangement. There are three outfalls on the beach for the crude sewage. The most important one, the eastern outfall, has just been extended seaward 300 yards, but there can be no doubt that with the incoming tide the sewage, highly diluted, is carried over the beach (clay and sand). On this beach cockles (and other shell fish, mussels, and winkles) are found in some abundance. Cockles are collected when the tide is down, by children and others, and it is not unusual for such people to force open the shells and eat the fish in an uncooked condition. They are, however, chiefly taken home and cooked by steaming in a saucepan until the shells are all open. The cockles are placed in a covered saucepan with a little water, and then put over the fire. As soon as the water boils, or even before, the shells open, and this is the sign of their being cooked. It is tolerably certain that this method of cooking does not effect sterilisation.

There are 497 waterclosets connected with the sewers. The scavenging is fairly satisfactory, the few remaining pail closets being emptied three times a week, and the ashbins weekly. There is a certain amount of overcrowding. This is decreasing on account of recent building operations, but house rental is high, and many recently erected houses contain two families. There is no isolation hospital. An arrangement has been made to send patients to the Rochford Rural District Hospital when that is completed.

In the brickfields a great deal of house refuse (soft core) from London is used. This is brought by barges and chiefly used in brick burning. The burning causes an effluvium nuisance the prevention of which has occupied much of the attention of the District Council, but it has not as yet been found possible to take any steps to prevent the nuisance without injuriously affecting the industry upon which so much of the prosperity of the town depends.

Order of Infection.	No. of House.	Date of Notification of First Case.	Date of Notification of Subsequent Cases.
1	No. 8	F., 15, July 10th.	M., 2, August 16th.
			M., 3, August 18th.
			F., 6, August 20th.
2	No. 9	F., 13, August 18th.	M., 19, August 29th.
			M., 38, September 6th.
			M., 8, September 6th.
			M., 15, September 11th.
			F., 10, September 22nd.
			M., 4, September 22nd.
3	No. 6	M., 7, August [illegible]th.	M., 32, September 20th.
4	No. 4	M., 9, September 5th.	M., 2½, September 9th.
			F., 30, September 9th.
			F., 7, September 11th.
			M., 36, September 17th.
5	No. 5	F., 27, September 15th.	
		M., 10, September 15th.	
6	No. 7	M., 25, September 16th.	
		M., 20, September 16th.	
7	No. 10	F., 3, October 24th.	

Out of the 10 houses, 7 have been infected, and there have been 23 persons attacked.

In the early part of the present year there had been few cases of typhoid fever; 1 in April, 2 in May, and 1 in June. There was a five weeks' interval between the last case in May and the one in June. This latter case the medical officer of health suspected to be due to eating cockles picked up from the beach. On July 10th a case was notified from a terrace of ten houses, only completed about two years ago, and in which the inspector could find no sanitary defects. The cases which occurred in this terrace are tabulated in column 1.

In the remainder of Shoebury there have only been eleven cases since July 1st. When the unusual incidence of fever in this group of houses was obvious, a sample of water from the main supplying the terrace, and samples of milk from each of the four dealers supplying the families residing there, were taken and examined chemically and bacteriologically in the County Public Health Laboratory.

The water was found in all respects satisfactory. Neither the bacillus coli nor bacillus enteritidis was discovered. Three of the samples of milk were of good average quality, and contained neither of the above organisms. The fourth was evidently mixed with water, and contained both organisms. This milk was being supplied to two houses only. It was being used in other parts of the town, but in no other house so supplied was there any case of fever. Although "fouled" there was no reason to suspect it as being the cause of the outbreak. In fact, neither milk nor water can be reasonably suspected as the cause of the outbreak. Not a single fact has come to light appearing to implicate either.

The houses are of very recent erection, and stand upon an estate which has been divided up into building plots. It was previously a meadow, so that the subsoil cannot be polluted. In construction they conform to all the model building bye-laws, and they appear to be in a very good sanitary condition. Each house drains separately into a sewer which runs behind, and is cut off from the sewer by a Weaver trap. This sewer, or combined drain, is also trapped off from the main sewer, which runs in front of the houses. Each house has a water closet upstairs and one in the yard, and the soil pipe is carried up in each house full bore and straight, to a few feet above the eaves. No smell has ever been observed from any of the soil pipes. The drains and soil pipes have been tested with smoke, and no defects were discovered. The sink pipes are properly disconnected and the yard paved. The closets have flushing cisterns, and appear in good order.

Two of the earlier cases of typhoid fever which occurred prior to the outbreak in the terrace were in houses connected with this sewer at points above the terrace, and the sewer has little fall. It would doubtless therefore become infected, and infected material could lodge in it, but it is difficult to see how this could affect the terrace. There is no reason to suspect any defects in the sewer or water main whereby one could affect the other.

Just above the terrace on the opposite side of the road is a kind of farmyard in which manure is stored, and some time ago some very offensive material was stored here. It was not deposited there until after fever had appeared, and as soon as complaints were made it was covered over, and the nuisance abated. This, therefore, can be excluded as the cause.

Most of the cottages were tenanted by persons working in the brickfields, and it was possible that they might have handled and been infected by the soft core used. Against this is the fact that only two of the persons attacked handled this material, and that no other case occurred amongst the very many who were constantly in contact with it. Could the effluvium from the brickfields carry contagion? Such an occurrence has not been recorded, and there are many houses nearer the brickfields than this terrace, and these houses have not suffered to nearly the same extent.

The two end houses of the terrace are occupied by persons in a much better position than those in the other houses. All the inhabitants of No. 1 have so far escaped. At the opposite end, No. 10, a girl, aged three, has just been attacked. Here, however, there is a possible cause. After fever had begun to spread it was decided to improve the ventilation of the main

sewer by running a tall shaft up the side of this house. When this was being done the tenant says there was a vile smell, which penetrated into the house. The date could not be fixed, but it was apparently between fourteen and twenty-one days prior to the child first appearing to be ill.

With the exception of the case last notified, all the usual cases of typhoid fever would appear to have had no part in producing the outbreak. There remains only for consideration the question of infected food. There is but one article likely to carry infection which has been eaten so largely or by so many of the sufferers as to merit serious attention. It has already been stated that the large expanse of foreshore is liable to sewage pollution, and that on this foreshore, lying upon and in the superficial layer of mud, cockles are comparatively abundant, and that these cockles are gathered by children and others, and are sometimes eaten uncooked. Samples of these cockles were collected by the sanitary inspector and submitted to examination. There were two lots, one gathered on the beach near the town, and the others further out nearer the sewer outfall. Three examinations were made of each batch (*a*) of the mud adhering to the shells, (*b*) of the fluid inside the shells, and (*c*) of the pulped body of the cockle. The results showed in every instance the presence of the bacillus coli communis, and of the spores of bacillus enteritidis sporogenes. There can be no doubt that all were sewage contaminated.

That the sewage of the town had been specifically infected for some time prior to the outbreak is undoubted, and it does not seem improbable, therefore, that shellfish bathed in such sewage, though diluted with sea water, may become specifically infected, and cause typhoid fever in susceptible people consuming them in an uncooked or imperfectly-cooked condition.

Dr. Walter, in cases which occurred in previous years and in two cases which occurred in the district this year prior to the cases in the terrace, had suspected cockles as the probable cause. One of these cases was notified on June 30th, a child, aged four, living in Wakering Road. No other cause could be assigned, and it was known that the child was in the habit of picking and eating cockles from the beach. The next case which occurred was in the terrace, and this was followed by one in West Road. In both these the eating of cockles appeared the most probable cause. Such being the case, careful inquiries were made at all the houses in the terrace, with the following results taken in order of invasion:—

"House No. 8. Four cases occurred here; the dates of notification show that some of the later ones were probably secondary, but they may have been due to the same cause as the first. Children often on the beach gathering cockles. Those brought home were cooked before being eaten. The family has since removed, and we could not get further details.

"House No. 9. Seven cases occurred in this house. The first notified was a girl, aged 13. The parents at first asserted that they rarely ate cockles, and that none had entered the house since May, and the child did not remember having had any. Afterwards the family acknowledged that all except the father often had cockles, and that the children were constantly on the beach during the summer months gathering them. They certainly had cockles on more than one occasion early in August, the last occasion being on or about August 9th, two days after Bank Holiday. This would account for the earlier cases, and the others were either secondary or caused by the children eating cockles as they picked them from the beach. The father denies ever touching shellfish.

"House No. 6. Two cases occurred here, the later one probably being secondary. The patient was a child, aged seven years. The six people in this house ate lots of cockles. They occasionally buy them, but more often pick them from the beach, and wash and boil them before eating. They know that they had some about a week before the child was taken ill.

"House No. 4. Of the eight people in this house, five contracted typhoid fever. Dr. Walter thinks that four of the five were primary cases, the fifth only being secondary. The family admit nearly living upon cockles picked from the beach, boiling them before use. In this house every person was attacked, save a baby aged four months, and a lodger and her child. The lodger and child never touched shellfish, and the baby was obviously too young to eat cockles.

"House No. 5. Of the three occupants of this house two had typhoid fever, and both were attacked at the same time, and notified September 15th. They only rarely partook of shellfish, but early in August (Bank Holiday) they had some oysters, and near the end of the month they had some cockles collected from the beach. These they cooked. This would be about the time when they become infected.

Appendix 7.

"House No. 7. Of the six persons in this house two contracted fever. One, a lodger, as soon as he felt ill went off home. The other was an adult, notified on September 16th, at which time the lodger was found to be ailing. This family rarely took shellfish, but about three weeks before the attack the people next door gave them a plate of boiled cockles. The people who gave them the cockles have since left. They only occupied the adjoining house for a few weeks and then removed.

"House No. 10. The last case notified in the terrace. One of the end houses occupied by a man in fairly good position. Patient a child aged three. The mother says that none of the children have ever tasted cockles, and she would not have such things in the house. The nuisance caused by erecting the ventilating shaft at the side of this house has already been referred to. Of the remaining three houses unattacked No. 1 (end house) the family had partaken of cockles several times during the summer. They did not pick them, but purchased them at the door. The other two houses are now unoccupied, and appear only to have been occupied occasionally, and for a few weeks at a time, since their completion."

The subjoined table shows that in the terrace referred to a larger proportion of males than females were attacked, that children suffered more, proportionally, than adults, and that about one-third of the occupants have had typhoid fever. Only three cases proved fatal. As the result of an inquiry we are strongly inclined to the opinion that this outbreak was due to the eating of cockles, and our reasons may be briefly summarised as under:—

Age and Sex of Occupants of Nine Occupied Houses in the Terrace.

——	Under 5.	Under 10.	Under 15.	Under 20.	Under 25.	Under 35.	Under 45.	Under 55.	Total.
Males.									
Attacked with typhoid fever	4	2	2	1	1	2	1	–	13
Not attacked	4	2	3	1	4	2	2	1	19
Females.									
Attacked with typhoid fever	2	3	1	2	–	2	–	–	10
Not attacked	3	3	3	2	4	3	5	–	23
Males and Females.									
Attacked with typhoid fever	6	5	3	3	1	4	1	–	23
Not attacked	7	5	6	3	8	5	7	1	42

1. There is no evidence tending to implicate the water supply.

2. There is no evidence tending to implicate the milk supply. It is true that one supply was impure, but it was only used in two out of the seven houses infected. The houses were supplied with milk from four different sources, and nothing occurred in any other part of the town to implicate any of the sources from which milk was obtained.

3. The drainage arrangements were unusually good.

4. The subsoil was free from polluting matter.

5. Cockles were eaten by nearly all the persons attacked, and these cockles were obtained from a source known to be polluted by sewage. Moreover, cockles gathered from this source showed when examined bacteriologically unmistakable signs of sewage pollution.

6. Cockles from the beach are consumed chiefly by newcomers to the district. The men in the garrison are expressly forbidden to eat any shellfish from the beach, and the older residents regard them with suspicion, it being well known that typhoid fever has been attributed to eating them. The residents in the infected houses were all recent arrivals in the town.

Appendix 8.

APPENDIX No. 8.

LETTER from SIDNEY BARWISE, Esq., M.D. (Lond.), D.P.H. (Camb.), and a REPORT on the PURIFICATION of SEWAGE at the BURTON SEWAGE FARM.

County Offices,
St. Mary's Gate,
Derby.

July 29, 1901.

Dear Sir,—With reference to the evidence I gave before the Royal Commission on Sewage Disposal on the purification of the Burton sewage at the Burton Farm, I should be glad if you would lay the enclosed report before the Commission.

Since I gave my evidence I have had an opportunity of trying the effect of a biological filter worked continuously with intermissions upon the Burton sewage, after precipitation with lime.

Briefly, the conclusions arrived at are:—

1. That the excessive amount of lime (the tank effluent containing as much as 8 grains of free lime to the gallon) is harmful.

2. That when the excess of lime is neutralised an excellent effluent can be produced by means of filtration when the filter is worked at the rate of half a million gallons per acre per day.

The results of daily analyses throughout 12 months are contained in the appendix to this report.

This table gives the organic ammonia in the tank effluent, and in the filtrate, the nitrogen as nitrates, the alkalinity of the tank effluent, the temperatures, and the rainfall.

If necessary, I will make an affidavit that the report is correct, or if preferred I will swear to it any time the Commission is sitting.

I am,
Your obedient servant,
SIDNEY BARWISE.

The Secretary of the Royal Commission on Sewage Disposal, 39, Victoria Street, Westminster, S.W.

To the Chairman and Members of the Public Health Committee of the Derbyshire County Council.

My Lord and Gentlemen,—As mentioned in the memorandum of an interview betwen Professor Dewar and myself, dated January 31st, 1899, subject to the approval, subsequently given, of your committee and the Corporation of Burton, it was agreed:—

i. That an experimental biological filter should be constructed and reported on by me.

ii. That a certain area of the farm should be set aside and used only for the deposition of sludge, and an adjoining area of land should be irrigated with clarified sewage only.

The experiments have now been in progress for twelve months, and the results obtained are of such an important character, that, for the information of your committee and the advisers of the Corporation, I have prepared an epitome of these results and the conclusions to be drawn therefrom.

It is, perhaps, worth while recalling that I had reported to your committee that the unsatisfactory character of the effluent from the Burton farm was, in my opinion, in part due to the deposit of carbonate of lime forming an impervious layer over the surface of the soil, thereby preventing the ready access of air into its interstices. It was also in my opinion partly due to the excess of lime acting detrimentally on the nitrifying organisms in the surface layers of the soil. To test these opinions, on a certain area of the farm known as Plot 16, the sludge has all been deposited in two trenches before the sewage is applied to the land.

PLOT 16.—The following are the result of analysis of the effluent from Plot 16, and in parallel columns the results of the analysis of the general effluent from the farm:—

Date.	Parts per 100,000.			
	Farm Effluent.		Effluent Plot 16.	
	Organic Ammonia.	Nitrogen as Nitrates.	Organic Ammonia.	Nitrogen as Nitrates.
17 Mar. 1900 -	—	—	·06	·35
23 Mar. ,, -	—	—	·05	·5
24 Mar. ,, -	·21	nil	—	—
31 Mar. ,, -	—	—	·05	—
18 May ,, -	·15	nil	·08	·3
22 May ,, -	·18	nil	—	—
26 May ,, -	—	—	·07	·4
2 June ,, -	—	—	·01	·03
14 June ,, -	·17	nil	·09	nil
23 June ,, -	—	—	·08	—
			Plot 16 rested from 23rd June to 1st September.	
1 Sept. ,, -	—	—	·12	—
7 Sept. ,, -	—	—	·05	·45
15 Sept. ,, -	·13	nil	·06	·35

It is impossible to say to what extent the alkalinity of the sewage applied to Plot 16 was neutralised by its running through the open carriers, but at any rate no suspended carbonate of lime was carried over on to the land so as to seal its surface. Plot 16 has an area of 17 acres, about 7 acres of which were irrigated on alternate days, so that the same area came into use every fifth or sixth day, while the rest of the farm, in use for the time being, is irrigated for a month or two on alternate days and then allowed to rest. The results obtained on Plot 16 are satisfactory. Nitrates are present to the extent of from ·3 to ·5 parts per 100,000. Assuming that Plot 16 was irrigated at the same rate as the rest of the farm, 30,000 gallons of sewage were applied per acre per day; but taking into consideration that only 7 out of the 17 acres were irrigated each day, it is more likely that only half this amount was applied to the land. When we remember that Plot 16, to give these results, needs prolonged rests of several months, it will be apparent that a large increase of the farm would be necessary if the whole of the sewage was to be treated on the same lines.

The suggestion is therefore made that certain areas of the farm should be levelled, and used as intermittent filters, to enable a larger quantity of sewage to be applied, while the rest of the farm is used for irrigation on the lines of Plot 16.

RESULTS OBTAINED BY BIOLOGICAL FILTRATION.

The experiments with the biological filter have consisted of:—

1.—Applying the clarified limed sewage after it has passed through a settling tank.

2.—Neutralising the excess of lime and applying the neutralised sewage to the filter.

3.—Allowing the sewage applied to the filter to gradually become alkaline again, the quantity of nitrates formed under the varying conditions being carefully noted.

The results obtained are set forth in the appendix to this Report.

It will be noticed that, although there was a large reduction in the organic ammonia immediately the coal filter was started, yet no nitrates were produced. This was to me a new experience with filters of this kind, and in November of last year I had the filter carefully seeded from an experimental filter at work at Buxton, which is actively nitrifying. This, however, had no result; the sewage was then being applied during 12 hours, the filter having a rest for 12 hours each night, the rate of filtration was 1,000,000 gallons per acre per day; the rate of filtration was reduced to half this quantity, and, although a reduction in the organic ammonia resulted, no nitrification took place. In December the quantity was further reduced to the rate of a quarter of a million gallons per acre per day, the sewage being applied intermittently every half hour, the filter also resting 12 hours during the night. This reduction did not induce nitrification, although it further reduced the organic matter in the filtrate. Accordingly in December I attempted to cause a reduction in the alkalinity by having part of the settling tanks made into an anaerobic bacteria bed by filling it with coarse gravel and letting the sewage travel through it laterally. I had hoped that some organisms would develop, which would give off carbonic acid and thereby neutralise the lime, but this did not happen. I noticed, too, that the surface of the coal filter was becoming caked and hard. The filter had now been at work nearly six months and no nitrates had appeared. I therefore obtained permission to neutralise the excess of lime by means of copperas. Although this was an extravagant way of doing it, for the purpose of the experiment, it was easily applied.

As the lime had, in my opinion, killed the nitrifying organisms which had been added to the filter, it was again seeded from actively nitrifying biological filters, and so that the conditions for nitrification should be as favourable as possible, the quantity applied was temporarily reduced to the rate of one hundred and twenty-five thousand gallons per acre per day. Nitrates soon made their appearance, and the rate of filtration was gradually increased to the rate of half a million gallons per acre per day, at which rate while the sewage was neutral or nearly so, an excellent effluent was produced, containing less than ·05 parts per hundred thousand of organic ammonia and more than one part of nitrogen in the completely oxidised form of nitrates.

I might, perhaps, here point out that while the tank effluent contained free lime to the extent of about eight grains per gallon, no sign of any kind of animal or vegetable life could be seen in the tanks, or the carrier conveying the tank effluent to the filters. The sewage showed no growth on gelatine plates, it was not only practically sterile, but killed worms and frogs if they happened to fall in. As soon, however, as the sewage was neutralised, various forms of animal and vegetable life could be seen in the tanks, and the carrier to the filter became coated with iron bacteria. The tank effluent now most readily oxidised into nitrates, and the filtrate from the filters contained numbers of the Tubifex Rivulorum, a perfectly harmless non-parasitic water organism.

The following table of analyses by the county analyst shows the condition of affairs at this time:—

Date of Collection, June 14th, 1900.

	Results expressed in parts per 100,000.				
	Limed Sewage.	Tank Effluent	Coal Filtrate.	Farm Effluent.	Effluent from Plot 16.
Total Solid Matter	198·0	165·0	146·0	169·0	137·0
Total Suspended Matter	0·0	0·0	0·0	4·8	4·0
Free Ammonia	0·927	1·240	0·015	0·390	0·120
Albuminoid Ammonia	0·620	0·380	0·045	0·160	0·080
Nitrogen as Nitrates	0·0	0·0	1·10	0·0	0·0
Chlorine	11·0	10·2	10·3	10·5	10·7
Oxygen, absorbed in 4 hours at 80 deg. Fahr.	5·566	3·432	0·246	1·700	0·900
Alkalinity as Lime (CaO).	10·64	1·12	0·0	0·0	0·0

An attempt was now made to work the filter at the rate of a million gallons per acre per day; unfortunately for the experiment, the sewage was very highly limed at the time, so that after the copperas had been added there was still four or five parts of free lime in it; the result was that the nitrates began to diminish. By reducing the rate of filtration, however, and adding more copperas, they were again increased to over one part per hundred thousand.

By August all the copperas had gone, and since then the lime has gradually increased up to eight parts per hundred thousand, and the nitrogen as nitrates is gradually diminishing. The filter is being worked at the rate of half-a-million gallons per acre per day.

The following table shows the alkalinity as lime and carbonate of lime in the limed sewage, farm effluent, effluent from Plot 16 and the coal filtrate:—

		Parts per 100,000.	
		CaO.	$CaCO_3$.
Limed Sewage	In suspension	3	40
	In solution	10	30
Farm Effluent		—	45
Effluent from Plot 16		—	32
Effluent from Coal Filter		—	20

The diminishing alkalinity as carbonate of lime is due to the formation of nitric and organic acids as a result of the oxidation of the organic matter in the sewage. The figures show the highly oxidised state of the effluent from the coal filter.

Conclusions:—

The conclusions which I think are to be drawn from these experiments are:—

i. That by a system of biological filtration combined with some modification of the present method of precipitation, a perfectly satisfactory effluent can be obtained, the filters being worked at the rate of half-a-million gallons per acre per day.

ii. That the excessive alkalinity of the sewage is harmful, killing the organisms in the surface layers of the soil, and thus preventing the effluent storing up oxygen by the aid of nitrifying and other oxidizing organisms.

iii. That the deposit of sludge on the surface of the farm is harmful.

Recommendations:—

As a result of the experience obtained, the question should be put to Professor Dewar whether he cannot advise the Corporation to modify the method of precipitation without risk of creating an aereal nuisance. The suggestions I would make are:—

i. That a smaller dose of lime should be added, and, after precipitation has taken place, a small dose of ferric sulphate or such other salt as Professor Dewar may advise.

ii. That rough biological filters or contact beds be constructed of clinker or other hard material, in such positions that the effluent from the filters can be irrigated over the land.

These filters need not cost anything like the same amount as the experimental filter, as since it was designed, various arrangements have been perfected for making bacteria beds practically automatic in their working.

iii. That the system tried with Plot 16 be further extended, so that where irrigation is adopted it is carried out as on Plot 16; it would, however, be better if the sewage were applied for much shorter periods than twenty-four hours.

To permit of this system being adopted with the present area of land, it will be necessary that part of the farm should be made capable of purifying the sewage at a much greater rate. For this purpose it is advisable that at least fifty acres should be properly laid out in carefully levelled horizontal beds (of about a quarter of an acre in extent) of ridges and furrows each about four feet wide, to be used as intermittent land filters; the sewage being applied in a similar manner to that in which it is to the intermittent land filters at Stratford-on-Avon. Here the sewage is applied for half-an-hour at a time, the land then has a rest for one hour, the sewage only being applied for four hours out of the twenty-four, and after five days the portion of the filter used has a rest for several weeks. Under this system four or five times the quantity of sewage can be purified on a given area.

On such a large scale as the Burton Farm it might be said there would be difficulty in working a large number of land filters with sufficient system, but by means of Mather and Platts' automatic sewage distributors or other mechanical appliances the proper intermittent application of the sewage to the land filters can be rendered quite automatic.

In making these recommendations for the consideration of Professor Dewar, I have endeavoured as far as possible to suggest nothing which can be regarded now as of an experimental nature, or anything opposed to the present method of treatment. I do not, therefore, wish it to be understood that these suggestions are the last word which can be said upon the question of the purification of the Burton sewage. It would be remiss on my part if I did not here gratefully acknowledge the great assistance the Sewage Committee of the Corporation of Burton have given me in watching the various experiments, and the kind help I have received from Mr. Lynam and the other officials of the Corporation I have been brought in contact with.

I am, my Lord and Gentlemen,

Your obedient Servant,

Sidney Barwise.

Derby, October 8th, 1900.

Appendix 8.

APPENDIX TO THE REPORT ON THE BURTON SEWAGE FARM.

RESULTS OBTAINED WITH EXPERIMENTAL BACTERIAL FILTER

Dates.	No. of Samples analysed.	Results expressed in parts per 100,000. Tank Effluent. Organic Ammonia.	Tank Effluent. Remarks on Tank Effluent.	Coal Filtrate. Organic Ammonia.	Coal Filtrate. Nitrogen as Nitrates.	Temperatures (Fahrenheit). Tank Effluent.	Temperatures (Fahrenheit). Coal Filtrate.	Temperatures (Fahrenheit). Air.	Rainfall at Blakeley Lodge. Inches	REMARKS.
FILTRATION AT THE RATE OF 200 GALLONS PER SQUARE YARD PER DIEM. Sewage applied continuously for 12 hours daily.										
1899:										
16 Oct.	1	·32	Free CaO 10	·10	nil	—	—	—	—	Limed sewage practically sterile.
30 Oct.	1	·42	—	·09	nil	—	—	—	—	- - ditto - - ditto.
1 Nov. to 4 Nov.	4	·44	—	·11	nil	61·5	60·1	54·1	·86	- - ditto - - ditto.
6 Nov. to 11 Nov.	6	·40	—	·11	nil	55·5	56·5	51·3	·83	- - ditto - - ditto.
13 Nov. to 18 Nov.	6	·48	—	·14	nil	54·0	54·4	46·3	nil	Filters seeded from Buxton filter.
										Filter resting 20 and 21 November.
22 Nov. to 25 Nov.	4	·48	—	·13	nil	53·0	54·2	49·2	nil	
27 Nov. to 2 Dec.	4	·53	Free CaO 10	·17	nil	52·8	55·0	49·0	·13	
FILTRATION AT THE RATE OF 100 GALLONS PER SQUARE YARD PER DIEM. Sewage applied continuously for 12 hours daily.										
4 Dec. to 7 Dec.	4	·36	—	·10	nil	52·1	51·9	48·3	snow ·24	
FILTRATION AT THE RATE OF 50 GALLONS PER SQUARE YARD PER DIEM. Sewage applied every alternate half-hour for 12 hours daily.										
8 Dec. to 16 Dec.	5	·47	Free CaO 14	·07	nil	44·1	46·7	below 40	snow ·24	
18 Dec. to 23 Dec.	6	·48	—	·09	nil	41·8	42·6	below 40	snow ·36	
										Filter resting 24 and 25 December.
26 and 27 Dec.	2	·56	—	·10	nil	below 40	43·8	below 40	part snow ·90	Tank effluent practically sterile.
										Filter resting 28 December to 12 January. Gravel put in settling tanks.
1900:										
13 Jan. to 20 Jan.	7	·57	Free CaO 11	·07	nil	42·2	43·5	43·1	part snow ·55	
22 Jan. to 27 Jan.	6	·40	Free CaO 12	·04	nil	45·9	44·6	47·7	part snow ·66	
29 Jan. to 3 Feb.	6	·44	—	·07	nil	41·2	43·3	below 40	part snow ·36	
5 Feb. to 10 Feb.	6	·40	Free CaO 13	·11	nil	below 40	40·7	below 40	part snow ·22	Filters worked alternate quarter-hours.
12 Feb. to 15 Feb.	4	·50	—	·17	nil	below 40	below 40	below 40	part snow ·82	
										Filter resting owing to Trent being in flood.
5 Mar. to 10 Mar.	6	·42	—	·13	—	43·9	43·0	40·8	nil	Filters worked alternate half-hours.
COMMENCED TO NEUTRALISE WITH COPPERAS.										
12 Mar. to 17 Mar.	6	·58	–	·09	trace	46·4	45·3	47·1	snow ·12	
19 Mar. to 24 Mar.	6	·48	—	·08	trace	43·0	45·0	41·6	·15	Filter seeded from Chesterfield and Kimberley filters
26 Mar. to 31 Mar.	6	—	—	·11	trace	45·2	43·7	42·3	snow ·21	
2 April to 5 April	4	—	—	·12	nil	51·2	45·8	48·2	·51	Effluent contained Tubifex Rivulorum.

Appendix 8.

FILTRATION AT THE RATE OF 25 GALLONS PER SQUARE YARD PER DIEM.										
12 and 14 April	2	·34	—	·09	nil	50·1	49·5	50·3	·40	ditto - - ditto.
16 April to 20 April	6	·34	Neutral	·07	nil	55·8	51·3	56·1	·09	ditto - - ditto.
23 April to 28 April	6	·25	Neutral	·09	·14	56·0	54·8	52·6	·19	ditto - - ditto.
FILTRATION AT THE RATE OF 50 GALLONS PER SQUARE YARD PER DIEM.										
30 April to 5 May	11	·25	Neutral	·07	·63	54·2	55·0	54·0	·30	Effluent from tank shows enormous growth on gelatine.
7 May to 12 May	6	·25	Neutral	·06	1·03	55·8	55·0	51·8	1·13	ditto - - ditto.
14 May to 19 May	6	·24	Neutral	·04	1·32	54·8	54·8	52·7	nil	ditto - - ditto.
21 May to 26 May	6	·20	Neutral	·06	1·66	57·8	55·5	57·0	·24	Free CaO in limed sewage 14·2.
FILTRATION AT THE RATE OF 100 GALLONS PER SQUARE YARD PER DIEM. Sewage being applied continuously for 12 hours daily.										
28 May to 2 June	6	—	—	·04	1·66	61·8	60·5	57·3	nil	*Filter resting 2 June to 7 June.*
7 June to 9 June	4	·19	CaO 1·1	·05	1·62	62·8	63·7	58·0	·63	Carrier from tanks to filter covered with growth of Cladothrix Dichotoma.
11 June to 14 June	3	·24	—	·04	1·36	67·6	66·3	68·5	1·68	Free CaO in crude sewage 10 parts per 100,000.
FILTRATION AT THE RATE OF 200 GALLONS PER SQUARE YARD PER DIEM.										
19 June to 23 June	5	·27	CaO 2	·04	1·36	66·3	68·0	60·6	·69	
25 June to 30 June	6	·30	CaO 4	·046	·37	64·6	66·3	62·5	·20	
2 and 3 July	2	·40	—	·045	·27	65·7	67·2	59·2	—	
FILTRATION AT THE RATE OF 100 GALLONS PER SQUARE YARD PER DIEM.										
4 July to 9 July	5	·40	CaO 5	·04	·18	64·6	65·6	62·8	·27	
FILTRATION AT THE RATE OF 50 GALLONS PER SQUARE YARD PER DIEM.										
10 July to 14 July	5	·20	CaO 2	·06	·38	73·7	69·2	73·8	·23	
16 July to 21 July	6	·20	CaO 2·5	·08	·77	72·9	71·5	72·4	·58	
23 July to 28 July	6	·30	—	·03	1·06	75·7	73·4	74·2	·95	
31 July to 7 Aug.	7	·32	—	·04	1·60	65·0	70·2	66·4	1·34	*Filter resting 8 to 13 August.*
COPPERAS ALL GONE.										
FILTRATION AT THE RATE OF 100 GALLONS PER SQUARE YARD PER DIEM.										
14 Aug. to 18 Aug.	5	·32	—	·04	1·56	69·7	67·9	67·9	nil	
20 Aug. to 25 Aug.	6	·24	CaO 6	·04	1·42	63·0	68·6	67·0	1·33	
27 Aug. to 1 Sept.	6	·42	—	·04	·30	62·7	65·5	64·6	·12	
3 Sept. to 8 Sept.	6	·36	CaO 8	·04	·26	64·6	65·5	61·6	nil	
10 Sept. to 15 Sept.	6	·37	CaO 8	·04	·26	63·2	65·4	61·6	—	
17 Sept. to 22 Sept.	6	·44	CaO 8	·04	·23	64·0	64·2	63·5	—	
24 Sept. to 28 Sept.	5	·50	CaO 6	·06	·24	61·0	63·0	59·8	—	

Appendix 9

APPENDIX No. 9.

A. Circular Letter to Sanitary Authorities in England and Wales enquiring whether they had conducted any experiments on the purification of sewage.

B. A copy of each form mentioned in the Circular Letter.

C. A selection from the Returns made by Authorities on the forms supplied.

Appendix 9A

APPENDIX No. 9A.

ROYAL COMMISSION ON SEWAGE DISPOSAL,
39, Victoria Street, S.W.,
December, 1900.

Sir,

I am directed by the Royal Commission on Sewage Disposal to enquire whether the Council have conducted any experiments as to the purification of sewage by any of the following or similar methods :—

A. Closed Septic Tank and Contact Beds.
B. Open Septic Tank and Contact Beds.
C. *Subsidence Tanks and Contact Beds after chemical precipitation.
D. Subsidence Tanks and Contact Beds.
E. Contact Beds.
F. Closed Septic Tanks followed by continuous filtration.
G. Open Septic Tank followed by continuous filtration.
H. Chemical precipitation, subsidence Tanks and continuous filtration.
K. Subsidence Tanks followed by continuous filtration.
M. Continuous filtration.

* The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

If so, I am to state that the Commission would be much obliged if the Council would kindly furnish them with the results of such experiments.

Forms have been prepared in regard to each of the above mentioned methods, lettered A, B, C, &c., shewing what results the Commission are anxious to see, and it will be of considerable convenience to the Commission to have the results submitted on these forms.

On learning what experiments have been conducted, I shall be happy to furnish you with suitable forms.

I am, Sir,
Your obedient Servant,
F. J. WILLIS,
Secretary.

Appendix 9B

Form A.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN CLOSED SEPTIC TANK AND CONTACT BEDS.

Name of authority - - - - - - - -

Population of district - - - - - - - -

Water supply per head of the population - - - gallons per day.

Estimated or measured dry weather flow of sewage - gallons per day

Is any trade refuse taken into the sewers? - - - -

If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse :

Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers? - - -

Officer under whom the experiment has been conducted

Name and qualification of chemist who has made the analyses - - - - - - - -

---

(1) (*a*) What is the capacity in gallons of the closed septic tank or tanks? - - - - - -

(*b*) If there was more than one tank, state whether they were worked in series or in parallel -

(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge? - - -

If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion - - - - - - - -

(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material? - -

(*b*) What was the depth of these beds? - - -

(*c*) What were the nature and size of the filtering material? - - - - - - -

(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not -

(5) What was the water-holding capacity of the coarse beds at end of experiment? was this measurement made after resting, and, if so, what was the duration of the resting? - - - - - -

(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material? - -

(*b*) What was the depth of these beds? - - -

(*c*) What were the nature and size of the filtering material? - - - - - - - -

(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not - - - - - - - -

(8) (*a*) What was the water-holding capacity of fine beds at end of experiment? - - - - -

(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting? -

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting - - - - - - -

(10) State by what method the tank liquor was distributed on the beds - - - - - - -

Appendix 9B.

(11) What was the average quantity of sewage in gallons dealt with daily? - - - - - - - -

(12) Was the quantity of sewage dealt with increased in time of storm? - - - - - - -

If so, state to what extent, and how the results were affected by such increase - - - - - -

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed - - - - - - -

(14) Give (*a*) the average of the analyses of the final effluent from the beds - - - - - -

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken - - - - -

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed - - - - - -

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible? - - - - - -

(15) Give a typical analysis of the crude sewage to which the experiment relates - - - - - -

(16) Between what dates was the experiment conducted?

If there were any periods of rest, state their duration - - - - - - - - -

(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths - - - - -

(18) Was any nuisance caused by the experimental works? - - - - - - - - -

(19) Is the experiment still proceeding? - - - -

If so, may the Commission inspect the works, should they deem it desirable to do so? - -

(20) Give particulars of any other observations of importance which were recorded - - - -

(21) What inferences have been drawn from the experiment? - - - - - - - - -

(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system —excluding the annual repayment of any loan - - - - - - - -

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen;

Signature of officer under whose direction the experiment was conducted.

Appendix 9B.

Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS.

Name of authority - - - - - - - -	
Population of district - - - - - - -	
Water supply per head of the population - - -	gallons per day.
Estimated or measured dry weather flow of sewage -	gallons per day.
Is any trade refuse taken into the sewers? - - -	
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse -	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers? - - -	
Officer under whom the experiment has been conducted -	
Name and qualification of chemist who has made the analyses - - - - - - - -	

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks? - - - - -	
(*b*) If there was more than one tank, state whether they were worked in series or in parallel -	
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge? - -	
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion - - - - - - - -	
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material? - -	
(*b*) What was the depth of these beds? - - -	
(*c*) What were the nature and size of the filtering material? - - - - - - -	
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not - - - - - - -	
(5) What was the water-holding capacity of the coarse beds at end of experiment? was this measurement made after resting, and, if so, what was the duration of the resting? - - - - - -	
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material? - -	
(*b*) What was the depth of these beds? - - -	
(*c*) What were the nature and size of the filtering material? - - - - - - -	
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not - - - - - - - - -	
(8) (*a*) What was the water-holding capacity of fine beds at end of experiment? - - - - -	
(*b*) Was this measurement made after resting, and if so what was the duration of the resting? -	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting - - - - -	

Appendix 9B.

(10) State by what method the tank liquor was distributed on the beds - - - - - - -

(11) What was the average quantity of sewage in gallons dealt with daily? - - - - -

(12) Was the quantity of sewage dealt with increased in time of storm?
If so, state to what extent, and how the results were affected by such increase - - - - - -

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed - - - - - - - -

(14) Give (*a*) the average of the analyses of the final effluent from the beds - - - - - -

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken - - - - - -

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed - - - - - - -

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible? - - - - - - -

(15) Give a typical analysis of the crude sewage to which the experiment relates - - - - -

(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration - - - - - - - - -

(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths - - - - - -

(18) Was any nuisance caused by the experimental works - - - - - - - - - -

(19) Is the experiment still proceeding?
If so, may the Commission inspect the works, should they deem it desirable to do so - - -

(20) Give particulars of any other observations of importance which were recorded - - - -

(21) What inferences have been drawn from the experiment? - - - - - - - -

(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan - - - - - - - - -

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Signature of officer under whose direction the experiment was conducted.

Appendix 9B.

Form C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS AFTER CHEMICAL PRECIPITATION.

Name of authority - - - - - - - -	
Population of district - - - - - - -	gallons per day.
Water supply per head of the population - - -	gallons per day.
Estimated or measured dry weather flow of sewage - -	
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers? - - -	
Officer under whom the experiment has been conducted	
Name and qualification of chemist who has made the analyses - - - - - - - -	

(1) What was the nature of the chemical or chemicals used? - - - - - - - - -	
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used? - - -	
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations - - - - - - -	
(4) What is the capacity in gallons of the subsidence tanks? - - - - - - - - -	
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed- - - - - -	
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent -	
(7) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	
(*b*) What was the depth of these beds? - - -	
(*c*) What were the nature and size of the filtering material? - - - - - - -	
(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not - - - - - - - - - -	
(9) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting - - - -	
(10) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material? - -	
(*b*) What was the depth of these beds? - - -	
(*c*) What were the nature and size of the filtering material? - - - - - - - -	
(11) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not- - - - - -	
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting - -	

Appendix 9P.

(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting - - - - - - - - -

(13) State by what method the settled sewage was distributed on the beds - - - - - - -

(14) What was the average quantity of sewage in gallons dealt with daily? - - - - - - - -

(15) Was the quantity of sewage dealt with increased in time of storm?

If so, state to what extent, and how the results were affected by such increase - - - - - -

(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed - - - - - - -

(17) Give (*a*) the average of the analyses of the final effluent from the beds - - - - - -

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken - - - - - -

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed- - - - - - -

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible? - - - - - - - -

(18) Give a typical analysis of the crude sewage to which the experiment relates - - - - - -

(19) Between what dates was the experiment conducted? If there were any periods of rest, state their duration

(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths- - - - - - - -

(21) Was any nuisance caused by the experimental works? - - - - - - - - - -

(22) Is the experiment still proceeding? If so, may the Commission inspect the works, should they deem it desirable to do so? - - - - -

(23) Give particulars of any other observations of importance which were recorded - - - - -

(24) What inferences have been drawn from the experiment? - - - - - - - - -

(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or n "Septic" action is produced.

Signature of officer under whose direction the experiment was conducted.

Appendix 9B.

Form D.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS.

Name of authority - - - - - - - -	
Population of district - - - - - -	
Water supply per head of the population - - - -	
Estimated or measured dry weather flow of sewage -	
Is any trade refuse taken into the sewers? If so, state from what processses it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers? - - -	
Officer under whom the experiment has been conducted	
Name and qualification of chemist who has made the analyses - - - - - - -	
(1) What is the capacity in gallons of the subsidence tanks? - - - - - - - -	
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed - - - - - -	
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent - -	
(4) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material? - -	
(*b*) What was the depth of these beds? - - - -	
(*c*) What were the nature and size of the filtering material? - - - - - - - -	
(5) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not - - - - - - - -	
(6) What was the water-holding capacity of the coarse beds at end of experiment? - - - - - If the measurement was made after resting, please give duration of the resting - - - - -	
(7) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material? - -	
(*b*) What was the depth of these beds? - - -	
(*c*) What were the nature and size of the filtering material? - - - - - - -	
(8) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not - - -	
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting -	
(9) State method of working of contact beds, *i.e.* number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting - - - - - - - -	

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(10) State by what method the settled sewage was distributed on the beds - - - - - -

(11) What was the average quantity of sewage in gallons dealt with daily? - - - - - - -

(12) Was the quantity of sewage dealt with increased in time of storm?

If so, state to what extent, and how the results were affected by such increase - - - - - -

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed - - - - - -

(14) Give (*a*) the average of the analyses of the final effluent from the beds - - - - - -

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken - - - - -

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed - - - -

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible? - - - - - -

(15) Give a typical analysis of the crude sewage to which the experiment relates - - - - - -

(16) Between what dates was the experiment conducted? If there were any periods of rest state their duration

(17) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths - - - - - -

(18) Was any nuisance caused by the experimental works?

(19) Is the experiment still proceeding?

If so, may the Commission inspect the works, should they deem it desirable to do so? - - - -

(20) Give particulars of any other observations of importance which were recorded - - - - -

(21) What inferences have been drawn from the experiment? - - - - - - - - -

(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers-

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan -

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no "Septic" action is produced.

Signature of officer under whose direction the experiment was conducted.

Appendix 9B.

Form E.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS.

Name of authority - - - - - - - -	
Population of district - - - - - -	
Water supply per head of the population - - -	
Estimated or measured dry weather flow of sewage -	
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers? - -	
Officer under whom the experiment has been conducted	
Name and qualification of chemist who has made the analyses - - - - - - - -	
(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material? - - -	
(*b*) What was the depth of these beds? - - -	
(*c*) What were the nature and size of the filtering material? - - - - - - - -	
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not -	
(3) What was the water-holding capacity of the coarse beds at end of experiment? - - - - -	
If the measurement was made after resting, please give the duration of the resting - - - -	
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material? -	
(*b*) What was the depth of these beds? - - -	
(*c*) What were the nature and size of the filtering material? - - - - - - - -	
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not - - - - -	
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting - - - - - -	
(6) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting - - - - - - - - -	
(7) State by what method the sewage was distributed on the beds - - - - - - - -	
(8) What was the average quantity of sewage in gallons dealt with daily? - - - - - - - -	
(9) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase - - - - -	

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(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed - - - - - - -

(11) Give (*a*) the average of the analyses of the final effluent from the beds - - - - - - -

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken - - - - - -

(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to the coarse bed - - - - - - -

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible? - - - - - - -

(12) Give a typical analysis of the crude sewage to which the experiment relates - - - - - - -

(13) Between what dates was the experiment conducted?

If there were any periods of rest, state their duration

(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths - - - - - - -

(15) Was any nuisance caused by the experimental works?

(16) Is the experiment still proceeding?
If so, may the Commission inspect the works, should they deem it desirable to do so? - - - -

(17) Give particulars of any other observations of importance which were recorded - - - - - -

(18) What inferences have been drawn from the experiment? - - - - - - - - - -

(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state - - -

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers -

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan -

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Signature of officer under whose direction the experiment was conducted.

Appendix 9B.

Form F.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN CLOSED SEPTIC TANK FOLLOWED BY CONTINUOUS FILTRATION.

Name of authority - - - - - - - -	
Population of district - - - - - - -	
Water supply per head of the population - - -	gallons per day.
Estimated or measured dry weather flow of sewage -	gallons per day.
Is any trade refuse taken into the sewers?	
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse -	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers - - -	
Officer under whom the experiment has been conducted -	
Name and qualification of chemist who has made the analyses - - - - - - - -	
(1) (*a*) What is the capacity in gallons of the closed septic tank or tanks? - - - - -	
(*b*) If there was more than one tank state whether they were worked in series or in parallel -	
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge? - - -	
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion - - - - - - - -	
(3) (*a*) What are the form, the area and depth of the filters? - - - - - - - -	
(*b*) State the nature and size of the filtering material -	
(*c*) Were the sides of the filters open or closed? -	
(4) What was the rate of filtration in gallons per square yard per 24 hours?	
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent -	
(5) What was the average quantity of sewage in gallons dealt with daily? - - - - - - - -	
(6) Was the quantity of sewage dealt with increased in time of storm?	
If so, state to what extent, and how the results were affected by such increase - - - - - -	
(7) State by what method the tank liquor was distributed on the filters - - - - - - - - -	
(8) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed - - - - -	
(9) Give (*a*) the average of the analyses of the final effluent from the filters - - - - - -	
(*b*) the best analysis and date when sample was taken, and	
(*c*) the worst analyses and date when sample was taken - - - - - - - - -	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters - - - - - - - -	
(*e*) the average of the estimations made of the solids in suspension in the final effluent Were these solids putrescible? - - - - - -	

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(10) Give a typical analysis of the crude sewage to which the experiment relates - - - -

(11) Between what dates was the experiment conducted?

If there were any periods of rest, state their duration - - - - - - - -

(12) Give particulars of any observations which have been made of the temperatures of the filters at different depths - - - - - - -

(13) Was any nuisance caused by the experimental works? - - - - - - - - -

(14) Is the experiment still proceeding?

If so, may the Commission inspect the works, should they deem it desirable to do so? - -

(15) Give particulars of any other observations of importance which have been recorded - - -

(16) What inferences have been drawn from the experiment? - - - - - - - -

(17) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state—

(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan -

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Signature of Officer under whose direction the experiment was conducted.

Form G.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK FOLLOWED BY CONTINUOUS FILTRATION.

Name of authority - - - - - - - -	
Population of district - - - - - - -	
Water supply per head of the population - - -	gallons per day.
Estimated or measured dry weather flow of sewage -	gallons per day.
Is any trade refuse taken into the sewers?	
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse - - - - - - - - -	
Is the storm, soil or surface water, wholly or partially excluded from the ordinary sewers - - -	
Officer under whom the experiment has been conducted	
Name and qualification of chemist who has made the analyses - - - - - - - -	

(1) (a) What is the capacity in gallons of the open septic tank or tanks?	
(b) If there was more than one tank state whether they were worked in series or in parallel -	
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge? - - -	
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion - - - - - - - -	
(3) (a) What are the form, the area and depth of the filters? - - - - - - - -	
(b) State the nature and size of the filtering material	
(c) Were the sides of the filters open or closed? -	
(4) What was the rate of filtration in gallons per square yard per 24 hours?	
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent -	
(5) What was the average quantity of sewage in gallons dealt with daily? - - - - - - -	
(6) Was the quantity of sewage dealt with increased in time of storm?	
If so, state to what extent, and how the results were affected by such increase - - - -	
(7) State by what method the tank liquor was distributed on the filters - - - - - -	
(8) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed - - - -	

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(9) Give (*a*) the average of the analyses of the final effluent from the filters - - - - - -	
(*b*) the best analysis and date when sample was taken, and	
(*c*) the worst analysis and date when sample was taken - - - - - - - -	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters - - - - -	
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible ? - - -	
(10) Give a typical analysis of the crude sewage to which the experiment relates - - - - - -	
(11) Between what dates was the experiment conducted ? If there were any periods of rest, state their duration - - - - - - - - -	
(12) Give particulars of any observations which have been made of the temperatures of the filters at different depths - - - - - - -	
(13) Was any nuisance caused by the experimental works ? - - - - - - - - -	
(14) Is the experiment still proceeding ? If so, may the Commission inspect the works, should they deem it desirable to do so ? - - - -	
(15) Give particulars of any other observations of importance which have been recorded - - -	
(16) What inferences have been drawn from the experiment ? - - - - - - - - -	
(17) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state—	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan -	

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Signature of Officer under whose direction the experiment was conducted.

Appendix 9B.

Form H.

EXPERIMENT ON THE TREATMENT OF SEWAGE BY CHEMICAL PRECIPITATION, SUBSIDENCE TANKS, AND CONTINUOUS FILTRATION.

Name of authority - - - - - - - -	
Population of district - - - - - - -	
Water supply per head of the population - - -	gallons per day.
Estimated or measured dry weather flow of sewage -	gallons per day.
Is any trade refuse taken into the sewers?	
If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers? - - - -	
Officer under whom the experiment has been conducted	
Name and qualification of chemist who has made the analyses - - - - - - - -	

(1) What was the nature of the chemical or chemicals used? - - - - - - - -	
(2) What was the normal proportion of chemical or of chemicals (in grains per gallon) used? - - -	
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations - - - - - - -	
(4) What is the capacity in gallons of the subsidence tanks? - - - - - - - - -	
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed - - - - - -	
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent	
(7) (*a*) What are the form, the area and depth of the filters? - - - - - - - -	
(*b*) State the nature and size of the filtering material	
(*c*) Were the sides of the filters open or closed? -	
(8) What was the rate of filtration in gallons per square yard per 24 hours? - - - - - -	
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent? -	
(9) What was the average quantity of sewage in gallons dealt with daily? - - - - - - - -	
(10) Was the quantity of sewage dealt with increased in time of storm? - - - - - - - -	
If so, state to what extent, and how the results were affected by such increase - - - - -	
(11) State by what method the tank liquor was distributed on the filters - - - - - - -	

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(12) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed - - - - - -

(13) Give (*a*) the average of the analyses of the final effluent from the filters - - - - - -

(*b*) the best analysis and date when sample was taken, and - - - - - - - -

(*c*) the worst analysis and date when sample was taken - - - - - - - - -

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters - - - - - - -

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible? - - - - - -

(14) Give a typical analysis of the crude sewage to which the experiment relates - - - - - -

(15) Between what dates was the experiment conducted? If there were any periods of rest, state their duration

(16) Give particulars of any observations which have been made of the temperatures of the filters at different depths - - - - - - - - -

(17) Was any nuisance caused by the experimental works?

(18) Is the experiment still proceeding?

If so, may the Commission inspect the works, should they deem it desirable to do so? - - - -

(19) Give particulars of any other observations of importance which have been recorded - - -

(20) What inferences have been drawn from the experiment? - - - - - - - - -

(21) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state—

(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers -

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan -

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of trogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no Septic" action is produced.

Signature of officer under whose direction the experi ent was conducted.

Form K.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS FOLLOWED BY CONTINUOUS FILTRATION.

Name of authority - - - - - - - - ______

Population of district - - - - - - - ______

Water supply per head of the population - - - ______ gallons per day.

Estimated or measured dry weather flow of sewage - ______ gallons per day

Is any trade refuse taken into the sewers?

If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse - - - - - - - - - ______

Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers? - - - ______

Officer under whom the experiment has been conducted ______

Name and qualification of chemist who has made the analyses - - - - - - - - ______

---

(1) What is the capacity in gallons of the subsidence tanks? - - - - - - - - - ______

(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed - - - - - - ______

(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent - - - ______

(4) (*a*) What are the form, the area and depth of the filters? - - - - - - - - ______

(*b*) State the nature and size of the filtering material ______

(*c*) Were the sides of the filters open or closed? - ______

(5) What was the rate of filtration in gallons per square yard per 24 hours? - - - - - - ______

State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent - ______

(6) What was the average quantity of sewage in gallons dealt with daily? - - - - - - ______

(7) Was the quantity of sewage dealt with increased in time of storm?

If so, state to what extent, and how the results were affected by such increase - - - - - ______

(8) State by what method the tank liquor was distributed on the filters? - - - - - - - - ______

(9) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed - - - - - - - ______

Appendix 9B.

(10) Give (*a*) the average of the analyses of the final effluent from the filters - - - - - -	
(*b*) the best analysis and date when sample was taken, and	
(*c*) the worst analysis and date when sample was taken - - - - - - - - -	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters - - - - - - - -	
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible? - - - - -	
(11) Give a typical analysis of the crude sewage to which the experiment relates - - - - - - -	
(12) Between what dates was the experiment conducted?	
If there were any periods of rest, state their duration - - - - - - - -	
(13) Give particulars of any observations which have been made of the temperatures of the filters at different depths - - - - - - - -	
(14) Was any nuisance caused by the experimental works? - - - - - - - - -	
(15) Is the experiment still proceeding?	
If so, may the Commission inspect the works, should they deem it desirable to do so? - - - -	
(16) Give particulars of any other observations of importance which have been recorded - - -	
(17) What inferences have been drawn from the experiment? - - - - - - - - - -	
(18) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state - -	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers - - - - - - - -	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan -	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no "Septic" action is produced.

Signature of officer under whose direction the experiment was conducted.

Form M.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE BY CONTINUOUS FILTRATION.

Appendix 9B.

Name of authority - - - - - - - ____________

Population of district - - - - - - - - ____________

Water supply per head of the population - - - ____________ gallons per day.

Estimated or measured dry weather flow of sewage - ____________ gallons per day.

Is any trade refuse taken into the sewers?

If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse ____________

Is the storm soil or surface water, wholly or partially, excluded from the ordinary sewers? - - - ____________

Officer under whom the experiment has been conducted - ____________

Name and qualification of chemist who has made the analyses - - - - - - - - ____________

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(1) (*a*) What are the form, the area and depth of the filters? - - - - - - - - ____________

(*b*) State the nature and size of the filtering material ____________

(*c*) Were the sides of the filters open or closed - - ____________

(2) What was the rate of filtration in gallons per square yard per 24 hours?

State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent - ____________

(3) What was the average quantity of sewage in gallons dealt with daily? - - - - - - - - ____________

(4) Was the quantity of sewage dealt with increased in time of storm?

If so, state to what extent, and how the results were affected by such increase - - - - - - ____________

(5) State by what method the sewage was distributed on the filters - - - - - - - - - ____________

(6) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed - - - - - - ____________

(7) Give (*a*) the average of the analyses of the final effluent from the filters - - - - - - - ____________

(*b*) the best analysis and date when sample was taken, and

(*c*) the worst analysis and date when sample was taken - - - - - - - - - ____________

(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to the filters - - - - - - - - ____________

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible? - - - - - - - ____________

(8) Give a typical analysis of the crude sewage to which the experiment relates - - - - - - - ____________

(9) Between what dates was the experiment conducted? If there were any periods of rest, state their duration ____________

Appendix B.

(10) Give particulars of any observations which have been made of the temperatures of the filters at different depths - - - - - -	
(11) Was any nuisance caused by the experimental works?	
(12) Is the experiment still proceeding? If so, may the Commission inspect the works, should they deem it desirable to do so? - - - -	
(13) Give particulars of any other observations of importance which have been recorded - - -	
(14) What inferences have been drawn from the experiment? - - - - - - - - - -	
(15) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state—	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers -	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan -	

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen:
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Signature of officer under whose direction the experiment was conducted.

Appendix 9C.

Form A.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN CLOSED SEPTIC TANK AND CONTACT BEDS. (SINGLE CONTACT.)

Name of authority	Batley Corporation.
Population of district	1,050 connected with this treatment.
Water supply per head of the population	For domestic purposes 12 gallons per day. For trade purposes 26 gallons per day.
Measured dry weather flow of sewage	15,000 gallons per day.
Is any trade refuse taken into the sewers?	Not into these sewers.
If so, state from what processes it is derived and, approximately, what percentage of the total dry-weather flow of sewage is made up of trade refuse	*Note.* This is an outlying district from which the sewage could not be taken to the outfall works without tunneling through a rocky hill.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially.
Officer under whom the experiment has been conducted	Oscar J. Kirby.
Name and qualification of chemist who has made the analyses	None made.
(1) (*a*) What is the capacity in gallons of the closed septic tank or tanks?	4,500 gallons.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	There are three tanks at different levels, consequently are worked independently of each other.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	These tanks have been working since August 1897 and have not yet had any sludge taken from them.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	*Note.* These beds are improvised by simply digging trenches in the fields and filling them up with coke. They fill during the day and empty during the night. Single contact of course.
(*b*) What was the depth of these beds?	2 feet average.
(*c*) What were the nature and size of the filtering material?	Coke broken to 2 inch cubes.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not	
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	
(*c*) What were the nature and size of the filtering material?	
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?	
(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?	

Appendix 9C.

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	See 3a.
(10) State by what method the tank liquor was distributed on the beds.	By an ordinary pipe.
(11) What was the average quantity of sewage in gallons dealt with daily?	15,000 gallons.
(12) Was the quantity of sewage dealt with increased in time of storm?	A little.
If so, state to what extent, and how the results were affected by such increase.	No appreciable difference.
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.	None made.
(14) Give (*a*) the average of the analyses of the final effluent from the beds.	
(*b*) the best analysis of the final effluent and date when sample was taken, and	
(*c*) the worst analysis of the final effluent and date when sample was taken.	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.	
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	
(15) Give a typical analysis of the crude sewage to which the experiment relates.	
(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	
(18) Was any nuisance caused by the experimental works?	None whatever.
(19) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes, certainly.
(20) Give particulars of any other observations of importance which were recorded.	
(21) What inferences have been drawn from the experiment?	The following, viz.:—That for comparatively small quantities of domestic sewage the method described is a cheap and efficient one.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

O. J. KIRBY.
Signature of officer under whose direction the experiment was conducted.

Form A.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN CLOSED SEPTIC TANK AND CONTACT BEDS.

Name of authority	Manchester.
Population of district	550,000 gallons.
Water supply per head of the population	Domestic use - 17 } Trade purposes - 11 } 28 gallons per day.
Estimated or measured dry weather flow of sewage	26,754,375 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Yes. Breweries, dye and bleach works, galvanising works, grease refineries, tanneries, manufactories of tar products, rubber goods works, tripe-dressing works, mineral water manufactories. 4 to 5 per cent.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enter the sewers. Storm overflows are provided at certain points, which are supposed to come into action at a dilution of five to one; in certain cases, however, they fail to answer their purpose.
Officer under whom the experiment has been conducted	Gilbert J. Fowler, M.Sc., F.I.C. (Supt.) W. Clifford, A.R.C.Sc.I. Edward Ardern, B.Sc. (Vict.) H. D. Bell, } A. C. Oddie, } Junior Assistants. E. Hadfield, }
Name and qualification of chemist who has made the analyses.	Under the direction of G. J. Fowler (Supt.)

(1) (a) What is the capacity in gallons of the closed septic tank or tanks? — 19,620 gallons.

(b) If there was more than one tank, state whether they were worked in series or in parallel.

(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?

If the sludge was removed from the septic tanks, state how often this was done, and, approximately, what quantity of sludge was removed on each occasion. — Once, at end of 20 months' working. About 65 tons. After 20 months' working the flow of sewage through the tank was stopped and the contents pumped out. After removing the water a stratum of about 3¾ feet was left. This was pumped out, as far as possible, by means of a chain pump. The residue which could not be reached by the pump was left in, averaging in depth about 3¼ in.; allowing for this residue, the total sludge in the tank was estimated at about 65 tons. The sludge removed contained 88·7 per cent. moisture. During the period of work the total flow of sewage through the tank was estimated at 14,400,000 gallons. Allowing 26·0 grains per gallon, suspended matter in the sewage, 240 tons of sludge, containing 90 per cent. moisture, would normally be produced. From the above results it might be calculated that not more than 30 per cent. of the total sludge requires to be dealt with in the tank. It must, however, be borne in mind that a large amount of suspended matter has found its way on to the surface of the beds, causing the level of this to rise. It is questionable also whether the sewage arriving at the septic tank contained its full proportion of suspended matter.

(3) (a) What was the water-holding capacity at commencement of experiment of the beds when filled with the filtering material? — 3,560 gallons.

(b) What was the depth of these beds? — 4 feet.

(c) What was the nature and size of the filtering material? — Screened clinker. Composed as follows from the bottom upwards:—
1 foot to pass 3 in. mesh, and rejected by 1 in.
2 foot 9 in. „ ¾ in. „ „ „ „ ⅛ in.
3 inches of residue from above, which will pass ⅛ in. mesh.

(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.

BED No. 6.

Date.	Gallons.	Remarks.
8th November 1898	3,560	Material dry.
9th „ „	3,330	8 hours draining.
28th April 1899	2,820	8 „ „
8th September „	2,480	8 „ „
13th November „	2,500	3 days rest.
14th „ „	2,340	8¼ hours draining.
1st March 1900	2,090	8 „ „
18th „ „	2,200	44 „ „
19th June „	2,000	8 „ „

Appendix C9.

(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?

(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

(*b*) What was the depth of these beds?

(*c*) What was the nature and size of the filtering material?

(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?

(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?

(9) State method of working of contact beds, *i.e.*, number of fillings per day of 24 hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

10 Nov.—8 Dec. 1898.	Each bed filled once a day between 6 a.m. and 6 p.m. by means of automatic gear; flow stopped during the night, and from Saturday noon to Monday morning. (*a*) 2 hrs.; (*b*) 1 hr.
8 Dec. 1898—2 Jan. 1899.	Beds Nos. 4, 5, 6 held full 2 hrs. by disconnecting gear. Flow stopped as in previous period.
2 Jan.—25 Feb. 1899.	Flow continuous (Saturday noon to Monday morning excepted). About two fillings per day on each bed. Beds 1, 2, and 3 worked by automatic gear. Cycle: (*a*) 2 hrs.; (*b*) 1 hr.; (*c*) ½ hr.; (*e*) 8½ hrs. Beds 4, 5, and 6, gear disconnected. Cycle: (*a*) 2 hrs; (*b*) 2 hrs.; (*c*) ½ hr.; (*e*) 7½ hrs.
25 Feb.—17 Mar. 1899.	Tank working 14 hrs. per day. Each bed filled twice per day. Gear disconnected. Cycle: (*a*) 1 hr. 20 min.; (*b*) 2 hrs.; (*c*) ½ hr.
17 Mar.—29 April 1899.	Tank working 18 hrs. per day. Flow stopped between noon and 6 p.m. 6 a.m.—12, noon, 1 filling on each bed. Gear disconnected. Cycle: (*a*) 1 hr.; (*b*) 2 hrs.; (*c*) ½ hr.; (*e*) 8½ hrs. 6 p.m.—6 a.m., 1 filling on each bed. Worked by automatic gear. Cycle: (*a*) 2 hrs.: (*b*) 1 hr.; (*c*) ½ hr.; (*e*) 8½ hrs.
29 April—20 Nov. 1899.	Tank working 18 hrs. per day. Flow stopped 6 a.m.—12 noon. 12 noon—6 p.m., 1 filling on each bed. Gear disconnected. Cycle: (*a*) 1 hr.; (*b*) 2 hrs.; (*c*) ½ hr.; (*e*) 8½ hrs. 6 p.m.—6 a.m., as in previous period.
20 Nov. 1899—17 Jan. 1900.	Tank working 20 hours per day. Flow stopped 1 a.m.—12 noon, and 12 noon—4 p.m., 1 filling on each bed. Gear disconnected 4 p.m.—6 p.m. Cycle: (*a*) 40 min.; (*b*) 2 hrs; (*c*) ½ hr. 6 p.m.—10 a.m., 9 fillings (2 fillings on three beds, 1 on the other three). Automatic gear. Cycle: (*a*) 1 hr. 45 min.; (*b*) 1 hr; (*c*) ½ hr.
17 Jan.—26 Dec. 1900.	Flow continuous (Saturday noon to Monday morning excepted). Each bed averages 2 fillings per day, for six days a week. Worked by automatic gear. Cycle: (*a*) 1 hr. 45 min.; (*b*) 1 hr.; (*c*) ½ hr.; (*e*) 8½ hrs.

(10) State by what method the tank liquor was distributed on the beds.

Beds, worked largely by the automatic gear of Messrs. Commerons, Commin and Martin, consist of tipping buckets, syphons, and connected wells. Tanks effluent distributed on the beds by means of channels made from half-pipes laid flush on the filtering medium.

(11) What was the average quantity of sewage in gallons dealt with daily?

23,000 gallons.

(12) Was the quantity of sewage dealt with increased in time of storm?

Rarely.

If so, state to what extent, and how the results were affected by such increase.

On one occasion extra fillings were put on, and the effluent continued good.

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.

Daily except Sundays. Samples shaken before analysis.

(14) Give (*a*) the average of the analyses of the final effluent from the beds.

The following numbers are the average of daily analyses of the filtrate during different periods corresponding to the different methods of working.

Parts per 100,000.

Date.	Four Hours Oxygen Absorption.	Incubator Test, 3 mins. Oxygen Absorption.		Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
		Before.	After.						
1898.									
Nov. 10—Dec. 7 -	3·17	1·91	1·54	57½—77	1·14	·14	·035	·12	15·3
Dec. 7—28 - -	2·67	1·54	1·38	9½—85	·80	·084	·03	·31	13·9
1899.									
Jan.—Feb. 23 - -	1·50	·95	·74	31—263	1·03	12	·036	·34	12·7
Feb. 25—March 17 -	2·38	1·48	1·38	40½—127	1·59	·19	·027	·32	17·4
March 17—April 29 -	1·81	·97	·68	21½—187	1·26	·13	·028	·35	16·1
April 30—Nov. 20 -	1·63	·77	·68	142—405	1·40	·115	·036	·66	16·0
Nov. 21—Jan. 17, 1900	1·54	·86	·63	8—66	1·04	·095	·035	·77	15·6
1900.									
Jan. 17—Dec. 26 -	1·93	1·03	·66	8½—404	1·02	·12	·043	·80	15·4

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken,

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Very little, except in the first flush, which contained much suspended matter and was often putrefactive.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of the daily analyses of the crude sewage for the quarter ending December 26, 1900:—

4 hours oxygen absorption - - -	11·46
3 minutes oxygen absorption - - -	5·47
Ammoniacal nitrogen - - - -	2·01
Albuminoid nitrogen - - - -	0·61
Chlorine - - - - - - -	16·6

(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.

Begun November 10th, 1898—still proceeding. Three weeks at time of emptying sludge, other occasional days—about one month in all.

(17) Give particulars of any observations which have been made of the temperature of the contact beds at different depths.

(18) Was any nuisance caused by the experimental works?

Very slight smell near the aerator channel.

(19) Is the experiment still proceeding?

Yes.

If so, may the Commission inspect the works, should they deem it desirable to do so?

Yes.

(20) Give particulars of any other observations of importance which were recorded.

Effect of Trade Refuse.—On December 2nd, 1899, an accidental discharge of ammonia recovery liquor into the sewer raised the oxygen absorption figure of septic tank effluent to upwards of 24 grains per gallon; this was reduced by the filters to 2·56, and no subsequent ill effects were noted.

First Flush and Drainage.—While the first flush from the bed was turbid and often putrefactive, the effect was not considered serious, as it did not last more than a few minutes; the drainings from the bed after emptying attain a high degree of purity, and when these are mixed with an equal volume of the first flush, the mixture is in general non-putrefactive.

Appendix 9C.

Effect of Filtrate on the Ship Canal Water.—A number of experiments have shewn that the filtrate from this installation contains enough residual oxygen dissolved and combined as nitrate to purify its own bulk of Ship Canal water.

Effect of Aerator.—No appreciable chemical difference could be detected in the tank effluent before and after it had passed the aerator. It is quite possible, however, that the liberation of the dissolved gases thus produced may excite a beneficial effect.

Gas produced in Septic Tank.—The gas obtained from the closed septic tank was found to be similar in composition to that evolved from the open septic tank, consisting chiefly of marsh gas with a small percentage of hydrogen and carbon dioxide.

Automatic Gear.—When all the working parts are in good condition the apparatus is capable of working smoothly and well. The corrosive action of the partially-purified septic tank effluent tends however to loosen any screws or nuts exposed to it and the pipes also are liable to become coated with deposit. Frequent attention is necessary from these causes. It was noticed that when a bed is tight on the surface, the water will not penetrate fast enough to enable the flow to be diverted from the bed before considerable ponding has taken place on the surface.

Maintenance of Beds.—The surfaces of the beds have been periodically raked and occasionally forked up to a depth of about 6 in. In process of time the surface has risen above the level of the distributing channels to an extent of some 6 in., the material having the general character of garden soil, which finally tends to impede the filling of the beds. If, however, this upper layer be removed, the clinker below is fairly loose. In one or two cases the upper layer has been removed, and on again putting the bed into use, it takes the freely, and in process of time the layer is reformed.

(21) What inferences have been drawn from the experiment?

Trade Refuse.—Save in exceptional circumstances, trade refuse as ordinarily met with is not seriously prejudicial to the working of this process, while the blending which takes place in the septic tank tends to obviate the effect of sudden rushes of manufacturing waste. The effect of iron pickle in the case of Manchester sewage is to cause more rapid silting-up of the septic tank and to increase the deposit on the beds, but it is not otherwise of serious effect.

Automatic Gear.—One difficulty of apparatus depending for its working on the rate of flow of sewage is that the cycle must vary with the flow, and is shortest when this is at its height; an increased flow, however, in dry weather coincides with the strongest sewage, and therefore some method of ponding up would have to be resorted to in this case. In the experiments described, the flow was kept pretty constant throughout the day. An inherent difficulty with automatic gear depending on the sewage flow is that the cycle of one bed is dependent on the condition as to capacity, character of surface, &c., of another bed, which will vary according to circumstances, length of working, weather, &c.

Maintenance of Beds.—It appears to be necessary that the surface of the beds should be raked about once a month. After about two years the surface of the beds should be removed and piled, in order to completely weather. In the meantime old weathered material may be spread on the surface. At rarer intervals, say five years, the clinkers below the surface may require to be washed to the depth of about one foot.

Number of Fillings.—The beds may safely take two fillings of septic tank effluent per day, after deducting all periods of rest.

(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

GILBERT J. FOWLER,
Signature of officer under whose direction the experiment was conducted.

Appendix 9C.

Form A.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN CLOSED SEPTIC TANK AND CONTACT BEDS. (SINGLE CONTACT.)

Name of authority - - - - - - - -	Slaithwaite Urban District Council.
Population of district - - - - - -	4570.
Water supply per head of the population - - -	gallons per day.
Estimated or measured dry weather flow of sewage -	100,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	No.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Surface water is excluded.
Officer under whom the experiment has been conducted -	Chairman of the Sanitary Committee, who is a manufacturing chemist.

Name and qualification of chemist who has made the analyses.	
(1) (*a*) What is the capacity in gallons of the closed septic tank or tanks?	100,000 gallons.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	In parallel.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	No.
If the sludge was removed from the septic tanks, state how often this was done, and, approximately, what quantity of sludge was removed on each occasion.	
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	Single contact fine beds only used.
(*b*) What was the depth of these beds?	
(*c*) What were the nature and size of the filtering material?	
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	About 12,000 gallons.
(*b*) What was the depth of these beds? - - -	5 ft. 6 in.
(*c*) What were the nature and size of the filtering material?	Furnace clinkers rejected by a ¼-inch screen.
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?	No change after working nearly two years.
(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	2 hours filling; 1 hour in contact. Average 3 fillings in 2 days.

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(10) State by what method the tank liquor was distributed on the beds.	Distributing troughs laid on the surface of the beds.
(11) What was the average quantity of sewage in gallons dealt with daily?	130,000 gallons.
(12) Was the quantity of sewage dealt with increased in time of storm?	Yes.
If so, state to what extent, and how the results were affected by such increase.	About 3 fold. No appreciable difference in effluent.
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.	
(14) Give (*a*) the average of the analyses of the final effluent from the beds;	
(*b*) the best analysis of the final effluent and date when sample was taken; and	
(*c*) the worst analysis of the final effluent and date when sample was taken;	Certified "very satisfactory" by the Inspector to the West Riding Rivers Board.
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed;	
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	
(15) Give a typical analysis of the crude sewage to which the experiment relates.	
(16) Between what dates was the experiment conducted?	
If there were any periods of rest, state their duration?	None.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	None.
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding? - - - -	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Certainly.
(20) Give particulars of any other observations of importance which were recorded.	
(21) What inferences have been drawn from the experiment?	The process is eminently satisfactory for domestic sewage.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;	About 5*s*. per head.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	About 3*d*. per head per annum.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

JAS. WOODHEAD,
Chairman of the Sanitary Committee.
Signature of Officer under whose direction the experiment was conducted.

Form A.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN CLOSED SEPTIC TANK AND CONTACT BEDS. (SINGLE CONTACT.)

Name of authority - - - - - - - -	Corporation of York.
Population of district - - - - - - -	About 75,000.
Water supply per head of the population - - -	33 gallons per day.
Estimated or measured dry weather flow of sewage -	45 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse:	Trade refuse is so small as to be negligible.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Storm water above the capacity of the sewers, yes. Soil or surface, no.
Officer under whom the experiment has been conducted -	City Engineer.
Name and qualification of chemist who has made the analyses.	(*a*) Thomas Fairley, F.I.C., F.R.S. Edin., F.C.S. London, etc., etc. (*b*) Edmund Moody Smith, M.D., C.M. Edin., D.P.H. Cam., Medical Officer of Health, York.

(1) (*a*) What is the capacity in gallons of the closed septic tank or tanks?	40,000.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	Only one.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	Yes, not more than 4 in. of sludge has been observed.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	The sludge has not been removed.
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	Not ascertained. There were 4 beds filled as described in (3) (*c*).
(*b*) What was the depth of these beds? - - -	3 feet.
(*c*) What were the nature and size of the filtering material?	Cinder, Coke, and Clinker.

—	No. 1.	No. 2.	No. 3.	No. 4.
	Ft. In.	Ft. In.	Ft. In.	Ft. In.
Rejected by $1\frac{1}{4}$ in. screen	– 3	—	—	– 3
$\frac{7}{8}$ in. to $1\frac{1}{4}$ in. -	1 3	—	—	—
$\frac{3}{8}$ in. to $\frac{3}{4}$ in. -	1 6	1 6	1 6	2 9
Rejected by $\frac{3}{4}$ in. screen	—	1 6	1 6	—
Total -	3 –	3 –	3 –	3 –

(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	Not ascertained.
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	Not ascertained.
(6) (*a*) What was the water-holding capacity at the commencement of experiment of the fine beds when filled with the filtering material?	There were no fine beds as distinguished from those described in (3) (*c*).
(*b*) What was the depth of these beds? - - -	
(*c*) What were the nature and size of the filtering material?	
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	

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(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?

(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?

(9) State method of working of contact beds, *i.e.* number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

As a rule:—
Three fillings per day of 24 hours, (*a*) 2 hours, (*b*) 2 hours, (*c*) $1\frac{1}{2}$ hours, (*e*) $2\frac{1}{2}$ hours. This was varied on occasions, but no better or worse results were obtained.

(10) State by what method the tank liquor was distributed on the beds.

By means of three semi-circular troughs.

(11) What was the average quantity of sewage in gallons dealt with daily?

About 40,000 gallons.

(12) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.

1st August 1899; 19th October 1899; 22nd November 1899; 6th, 14th, 21st and 29th September 1900.

(14) Give (*a*) the average of the analyses of the final effluent from the beds.

Total solids	72·01
Mineral matter	63·88
Volatile and organic matter	8·126
Free ammonia	3·41
Albuminoid ammonia	0·269
Nitrogen as calcium nitrate	under 0·01
Nitrogen as nitrites	nil
Oxygen required to oxidise organic matter in 4 hours	1·151
Reaction	Alkaline
Chlorine	12·03
Sediment	0·24
Containing organic matter	trace
Analyst	Mr. Fairley

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken.

—	Best.	Worst.
	19 Oct. 1899	1 Aug. 1899
Total solids	67·51	76·7
Mineral matter	63·2	64·2
Volatile and organic matter	4·31	12·5
Free ammonia	2·23	1·657
Albuminoid ammonia	0·157	0·257
Nitrogen as calcium nitrate	Nil	Under 0·01
Nitrogen as nitrites	Nil	Nil
Oxygen required to oxidise organic matter in 4 hours	0·67	1·57
Reaction	Alkaline	Alkaline
Chlorine	10·21	14·54
Sediment	1·68	Nil
Containing organic matter	Nil	Nil
Analyst	Mr. Fairley	Mr. Fairley

"Best" and "Worst" are so judged by "Oxygen (4 hours)."

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.

Not ascertained.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Trace only, on one occasion there was 1·68. Not putrescible.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

Total solids	84·27
Mineral matter	69·47
Volatile and organic matter	14·8
Free ammonia	5·21
Albuminoid ammonia	0·386
Nitrogen as calcium nitrate	Nil
Nitrogen as nitrites	Nil
Oxygen required to oxidise organic matter in 4 hours	4·157
Reaction	Alkaline
Smell (when cold)	very offensive
Chlorine	10·64
Sediment	21·83
Containing organic matter	17·7
Analyst	Mr. Fairley

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(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	22nd April, 1899, to 28th October, 1900. Each filter was allowed a week's rest alternately.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	No observations.
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding?	Yes, but with reconstructed beds, the sides being now of brickwork.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(20) Give particulars of any other observations of importance which were recorded.	No observations in connection with this experiment. I should like, however, to place on record an experiment made with two plots of land, each one-eighth of an acre, spade trenched over 2 ft. in depth and under-drained. The land experimented upon is characteristic of the whole district. 14th June, 1899, commenced at 8 a.m. to run septic tank filtrate on to each plot alternately until August 16th, when it was stopped; each bed was worked alternately for 12 hours and then rested for 12 hours. The reason for stopping this experiment was that the land was not taking the effluent; it was passing out some other way. An analysis made on August 1st by Mr. Fairley showed septic filtrate ·18 albuminoid ammonia and 1·1 oxygen absorbed in 4 hours in grains per gallon, while the filtrate from land showed ·15 albuminoid ammonia and ·79 oxygen. The second contact bed effluent at the same time showed ·14 albuminoid ammonia and ·67 oxygen. On the 4th November Colonel Slacke, Local Government Board Inspector, made an inspection of the works. The day before his visit septic tank effluent or filtrate had again been turned on to the land. It should be stated that the effluent was still standing on the land 15 days after the last flooding on the 16th August. As showing the unsuitability of the land for filtration of sewage, a hole about 1 ft. 6 in. long by 9 in. wide and 12 in. deep was made in one of the shallow furrows in Plot 2, the septic filtrate running along the furrow immediately filled the hole. A second hole of similar size was made on the ridge immediately adjoining at a distance of 9 in. from the first hole; this was perfectly dry, the intervening space was gradually sliced away until only 1½ in. of soil separated the two holes. There was still no moisture in the second hole. A pencil was then forced into the slight barrier for ¾ in.—still no moisture—and it was only when the pencil was passed through to the first hole that a slight trickle came through into No. 2. By this time the side of No. 2 nearest to No. 1 showed signs of sweating.
(21) What inferences have been drawn from the experiment?	That the system is superior to chemical precipitation, but not equal to either (1) Double contact beds; (2) open septic and contact beds; or (3) open septic and continuous filtration. We have been disappointed with the results of the closed septic tank and beds.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	It is practicable but not desirable, as other experiments have given better results.
(a) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	No estimate has been prepared.
(b) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	Ditto. ditto.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen - - - - - Albuminoid nitrogen - - - - - Nitrous nitrogen - - - - - Nitric nitrogen - - - - - - Total organic nitrogen - - - -	This cannot now be done; the analyses are given as received. A standard form for sewage analyses is very much needed.

A. Creer.
Signature of officer under whose direction the experiment was conducted.

Appendix 9C.

Form A.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN CLOSED SEPTIC TANK AND CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority - - - - - - -	Sefton Rural District Council.
Population of district - - - - - - -	(Portion Kirkby Park) 80.
Water supply per head of the population - - -	27 gallons per day.
Estimated or measured dry weather flow of sewage -	1600 gallons per day.
Is any trade refuse taken into the sewers? - - -	Domestic, no trade refuse.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially excluded.
Officer under whom the experiment has been conducted -	Building Surveyor and Sanitary Inspector.
Name and qualification of chemist who has made the analyses.	

(1) (*a*) What is the capacity in gallons of the closed septic tank or tanks?	4,000.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel	Only one tank.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	Yes.—Once.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	Contained about 90 cubic ft. Matter in suspension being noticed in the effluent, which was clogging the beds, the tank was opened November 23, after being in operation 8 months. A black dense scum 7 inches thick was found on top, containing half rotten paper, corks, matches, and fibrous material. Upon opening the valve (fixed 14 inches above the floor of tank for emptying) the contents subsided to its level. On further examination found:—Scum 7 inches thick, water 3 inches, deposit 4 inches, suspended matter in effluent due to obstruction in storm-overflow, allowing storm water to pass into tank.
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	250 gallons.
(*b*) What was the depth of these beds? - - -	1 ft. 6 in.
(*c*) What were the nature and size of the filtering material?	$\frac{3}{4}$ in. and $\frac{1}{2}$ in.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No reliable measurements, but estimate the beds have little more than half the water-holding capacity as at first.
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and if so, what was the duration of the resting?	
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	1 ft. 6 in.
What were the nature and size of the filtering material?	$\frac{1}{2}$ in. to $\frac{3}{8}$ in.
Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	Same as coarse bed.
(*a*) What was the water-holding capacity of fine beds at end of experiment?	
(*b*) Was this measurement made after resting and, if so, what was the duration of the resting?	

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(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	*a*. 5 or 6 times. *b*. Varying from ½ to 1 hour according to flow. *c*. 10 minutes. *e*. Varying from ½ to 1 hour.
(10) State by what method the tank liquor was distributed on the beds.	Direct by automatic syphons (no troughs).
(11) What was the average quantity of sewage in gallons dealt with daily?	1,600 gallons.
(12) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	Yes. Improved by dilution, not good afterwards.
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.	
(14) Give (*a*) the average of the analyses of the final effluent from the beds.	
(*b*) the best analysis of the final effluent and date when sample was taken, and	
(*c*) the worst analysis of the final effluent and date when sample was taken.	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.	None discernible to the eye.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Good at first, but bad as filters began to sludge up after 6 months, constant work.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	None taken.
(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	None.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	None taken, but on two occasions ice ¼ in. thick formed over the portion containing syphon in the coarse bed. No ice on fine bed.
(18) Was any nuisance caused by the experimental works?	None.
(19) Is the experiment still proceeding? If so, may the Commission inspect the works, should they deem it desirable to do so?	Under alteration for the purpose of experiment for the precipitation of matter in solution.
(20) Give particulars of any other observations of importance which were recorded.	Any offensiveness noticed at the time of the discharge of filtrate had completely disappeared by the time it reached Waddagor Lane, 370 yards distant. It had evidently become oxidized and clarified during its passage down an open ditch for this distance.
(21) What inferences have been drawn from the experiment?	The filter area is insufficient in this case. Filters should receive a fixed quantity at a time from a measuring tank. Filters should be of sufficient capacity to work only once a day. Storm water, except in very small quantities, should be excluded. Double contact is necessary.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	Yes.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	£2 11*s*. 0*d*.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	Nil.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

F. Pool.

Signature of officer under whose direction the experiment was conducted.

Appendix 9C. Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN CHANNEL AND CONTACT BEDS. (SINGLE CONTACT.)

Name of authority	Carlisle.
Population of district	42,000, estimated.
Water supply per head of the population	29·45 gallons per day.
Estimated or measured dry weather flow of sewage	1,317,000 gallons per day. In addition to the above a quantity of clean subsoil water finds its way into the sewers.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Yes. Liquid waste from dyeing processes, wool scouring, engine and condensing water. Waste water from felt washing at hat works. About 38 per cent.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted	Henry C. Marks, City Engineer.
Name and qualification of chemist who has made the analyses.	Dibdin and Thudichum, London.

(1) (*a*) What is the capacity in gallons of the open channel or tanks?	22,000 gallons.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	Only one channel.
(2) Were any observations made as to the filling up of the channel by deposit of sludge?	Yes.
If the sludge was removed from the channel, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	Sludge accumulated until septic action was established, and it then disappeared, becoming soluble. No deposit has taken place since.
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	50,600 gallons average.
(*b*) What was the depth of these beds?	Averaging 3 ft. 10 in.
(*c*) What were the nature and size of the filtering material?	Red sandstone broken into large pieces varying from 1 in. to 5 in. in diameter.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	In work.
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	Present capacity 46,600 gallons. Beds still working. Each bed rests about 24 hours per week.
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	No fine beds.
(*b*) What was the depth of these beds?	No fine beds.
(*c*) What were the nature and size of the filtering material?	No fine beds.
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	No fine beds.
(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?	
(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Almost three. Filling - 1¾ hours Standing full - 2 „ Emptying - 3¼ „ Resting - 2 „ 9
(10) State by what method the tank liquor was distributed on the beds.	Open wooden troughs.

11) What was the average quantity of sewage in gallons ealt with daily?	June to August - - - - - 200,000 gallons. August to November - - - 450,000 „ Since November - - - - - 466,000 „ 3)1,116,000 372,000
(12) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No, we pump our sewage from the outfall sewer as we require it.
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.	July 10th, August 16th, October 23rd, November 27th, 1900. January 9th, 1901. Settled.
(14) Give (*a*) the average of the analyses of the final effluent from the beds. (*b*) the best analysis of the final effluent and date when sample was taken, and (*c*) the worst analysis of the final effluent and date when sample was taken.	Fine beds not constructed.
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.	18·4 parts per 100,000.
(*e*) the average of the estimations made of the solids in suspension in the coarse bed effluent. Were these putrescible?	4·8 parts per 100,000. No fine beds yet.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	Chlorine - - - - 6·3 parts per 100,000. Ammoniacal nitrogen - - 2·000 „ Albuminoid nitrogen - - 0·324 „ Oxygen absorbed in 4 hours - 3·71 „ Suspended matters - - 24·0 „
16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration	June to present date. 24 hours each week, and for short periods due to temporary engine breaking down.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	Not taken.
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding? If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes. Yes.
(20) Give particulars of any other observations of importance which were recorded.	The work has been interrupted in consequence of the pumping arrangements being incomplete, with the result that after each resumption of work the effluents were not up to the quality of those obtained when the beds had been working systematically.
(21) What inferences have been drawn from the experiment?	That the sewage can be purified by these very coarse beds to the following extent:— *Sewage between 6 a.m. and 1 p.m. November 27th, 1900.* Suspended matters reduced by 81·0 per cent. Dissolved impurities albuminoid nitrogen by 30·9 per cent. Dissolved impurities oxygen absorbed by 26·9 per cent. These effluents maintained their aeration fairly well. The beds had been working steadily for about two months. *Sewage between 2.45 p.m. and 9 p.m. January 8th, 1901.* Suspended matters reduced by 76·8 per cent. Dissolved impurities albuminoid nitrogen by 31·7 per cent. Dissolved impurities oxygen absorbed by 23·1 per cent. The effluents did not maintain their aeration for 24 hours. The working of the beds had been interrupted by the pumping arrangements.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state (*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers. (*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	Yes.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Henry C. Marks,
City Engineer.
Signature of officer under whose direction the experiment was conducted.

Appendix 9C.

Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS. (SINGLE CONTACT.)

Name of authority - - - - - - -	Haslingden, Rawtenstall, and Bacup Outfall Sewerage Board.
Population of district - - - - - - -	73,000.
Water supply per head of the population - - -	25 gallons per day.
Estimated or measured dry weather flow of sewage -	Two million gallons per day.
Is any trade refuse taken into the sewers? - - - - If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	No. The sewers are only constructed for domestic sewage requirements. Some dye works or print works refuse has by accident got in. The source is not yet traced
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially. The surface water is, where practicable, turned into the river.
Officer under whom the experiment has been conducted.	The replies refer to the whole works.
Name and qualification of chemist who has made the analyses.	The analyses of the Mersey and Irwell Joint Rivers Committee have been taken.

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	About 2,000,000 gallons.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	Four tanks, each 180 feet, long by 60 feet average depth 7½ feet. All at work together.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	Yes. There is only a small deposit. On 5th February, 1900, it was reported that the deposit of sludge in 9 weeks was less than deposit under chemical precipitation for 4 weeks.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	None has been removed since, and the deposit of sludge has not increased to any extent.
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	The artificial filter beds are 16 in number, each 45 feet long by 30 feet wide and 5 feet deep. Total area 2,400 superficial yards.
(*b*) What was the depth of these beds? - - -	5 feet, filtering media 3 feet deep.
(*c*) What were the nature and size of the filtering material?	Filters constructed as follows:—4 inch drain tiles on the floor surrounded with burnt ballast, 8 inches of coarse coke, 4 inches of burnt ballast with aerating pipes laid in same, 14 inches of coarse and fine coke mixed, the whole covered with 6 inches of fine clinker cinders.

Note.—In actual working it was found that a thin scum formed over the top layer of finer material, causing a clogging in the working unless constantly cleaned. It has now been found that coarse clinkers and coke of the size of a walnut or a little larger is much more effectual than the fine clinker cinders, which are being gradually replaced.

(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	None made.
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	This is not an experiment but work in actual use, and they are still in use.
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	Have none. The coarse filter filtrate is passed on to land for final treatment.
(*b*) What was the depth of these beds?	
(*c*) What were the nature and size of the filtering material?	
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?	
(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?	

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(9) State method of working of contact beds, *i.e.*, number of fillings per day of 24 hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	The contact beds are worked as follows: They are filled twice during the day (12 hours). The filling takes about three hours, they stand full one hour; they are then run off in about two hours, and rest during the night for 12 hours.
(10) State by what method the tank liquor was distributed on the beds.	By carriers and penstocks and valves with side distributing troughs.
(11) What was the average quantity of sewage in gallons dealt with daily?	The works filter and land deal with 2,000,000 gallons daily.
(12) Was the quantity of sewage dealt with increased in time of storm?	The storm increase was dealt with by storm overflows working when sewage diluted eight times.
If so, state to what extent, and how the results were affected by such increase.	
(13) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to settle before being analysed.	None were made except those of the Inspectors of the Mersey and Irwell Joint Rivers Committee.
(14) Give (*a*) the average of the analyses of the final effluent from the beds. *Note.*—The analyses are of the filtrate after land treatment as well as beds.	Oxygen absorbed four hours test, grains per gallon, ·94.
(*b*) the best analysis of the final effluent and date when sample was taken, and	November 13, 1900. 3 p.m. Fine weather, heavy rain previous day. Oxygen absorbed four hours test, grains per gallon, 0·28.
(*c*) the worst analysis of the final effluent and date when sample was taken.	July 13, 1900. 1.15 p.m. Fine weather. Oxygen absorbed as before, 1·38.
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.	None made.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	None made.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	see table below

	Grains per gallon.
Chloride combined	4·26
Ureal ammonia	0·868
Albuminoid ammonia	0·476
Oxygen absorbed from permanganate of potash at 80° F. in four hours	2·80
Total solids	48·00
Mineral	32·00
Volatile	16·00

Hardness, 35 degrees.

(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	The observations furnished are on the working of the whole works.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding?	The works are still being carried on in the same way. The saving between this and the old chemical precipitation system being over 1,000*l.* a year.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes. Certainly.
(20) Give particulars of any other observations of importance which were recorded.	
(21) What inferences have been drawn from the experiment?	
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state.	As before stated the disposal of the whole sewage is effected by this means.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	It is impossible to say. So much depends on the adaptability of the soil (*i.e.*, clay land may not require concrete works, &c.), and the nature of the construction.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	4*s.* 6*d.*

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

RICHD. WM. BUGLER.
Clerk to the Board.

Appendix 9C.

Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS. (SINGLE CONTACT.)

Name of authority - - - - - - -	Hendon Urban District Council.
Population of district - - - - - -	22,500. About 18,000 to 19,000 drained to outfall works at present.
Water supply per head of the population - -	About 35 gallons per day.
Measured dry weather flow of sewage - - - -	700,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Laundry work may be regarded as the staple industry of the place. This is also a residential suburb of London.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	In nearly all the roads there is a separate surface water drain as well as a sewer, and such surface water drain takes the water from the front roofs of most of the houses as well as all the surface water from the roads themselves.
Officer under whom the experiment has been conducted	Engineer and Surveyor.
Name and qualification of chemist who has made the analyses.	Mr. Frank W. Andrew, M.R.C.S., L.R.C.P., Medical Officer of Health for Hendon. Dr. Houston (crude sewage and resulting effluent from Col. Ducat's Filters). Dr. Bevan, County Analyst.

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	Only one tank out of the six chemical precipitation tanks referred to in Form "C." has been used as an open septic tank. (5th November, 1900.)
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	About one foot of sludge appears to have collected on the bottom of the tank in two and a-half months.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion	No sludge has been removed up to the present.
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	We have only one set of contact beds at present, consisting of three bacteria beds, each of 800 yards superficial area and five feet deep. Bed No. 1 was constructed in September 1898, bed No. 2 September 1899, bed No. 3 December 1900; cost of each bed which is surrounded with concrete walls and floor averages 1,000 *l.* each; 3,000 *l.* the three beds.
(*b*) What was the depth of these beds?	
(*c*) What were the nature and size of the filtering material?	$\frac{3}{4}$ in. clinker pan breeze rejected by a $\frac{1}{8}$ in. sieve which removed the fine stuff.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	Each of the beds holds about 120,000 gallons of sewage. Effluent at one filling and no reduction in capacity has been noticed at present.
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	See No. 4.
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	No "fine" beds at present.
(*b*) What was the depth of these beds?	
(*c*) What was the nature and size of the filtering material?	

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(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?

(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?

No fine beds at present.

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

Each bed filled and emptied once a day only, resting all night and Sundays.

(10) State by what method the tank liquor was distributed on the beds.

After passing through an area of two acres of land, laid out on the intermittent downward filtration principle, the effluent from such intermittent downward filtration area is discharged on to the coarse bacteria beds by concrete carriers and galvanized iron sluices in the carriers.

(11) What was the average quantity of sewage in gallons dealt with daily?

(12) Was the quantity of sewage dealt with increased in time of storm?

Yes.

If so, state to what extent, and how the results were affected by such increase.

With 1 in. rain in 24 hours if during rainy time, the dry weather flow is increased four times, *i.e.*, to 2,000,000 gallons. A better effluent obtained with small quantity of rain, compared with effluent during a dry summer.

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.

Samples allowed to settle, made from time to time, not at stated or regular intervals.

(14) Give (*a*) the average of the analyses of the final effluent from the beds;

Free ammonia 1·4 parts per 100,000.
Alb. „ ·14 „ „ „
The amount of albuminoid ammonia in the crude sewage has been found by Dr. Houston as high as 7·6 per 100,000, and by Dr. Bevan 8·4 parts per 100,000. The albuminoid ammonia is never less than 3 parts per 100,000 on an ordinary day and in dry weather is much more frequently run up to 8 parts per 100,000 and over.

(*b*) the best analysis of the final effluent and date when sample was taken; and

Alb. NH_3 ·13 per 100,000 on 13th February 1899.

(*c*) the worst analysis of the final effluent and date when sample was taken;

Alb. NH_3 ·17 per 100,000 on 18th May 1900.

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed;

Cannot give this.
Dr. Barwise found in the crude sewage 315 parts of solid matter per 100,000, 198·5 parts of which were in suspension.
20th November 1897:
Free ammonia 6·16 parts per 100,000.
Organic ammonia 3·8 parts per 100,000.
Professor Corfield found on 10th May 1898:
Total solids 265·3 parts per 100,000.
Fixed 115·1 parts per 100,000.
Volatile 150·2 „ „ „

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Dr. Bevan:

Total solids dried at 212° F.	13·4
Solids in suspension	none
Solids in solution	130·4
Mineral matter in solution	1·43
Alb. Ammonia	·143
Oxygen consumed in 32 hours	·51
Chlorine	14·3

Dr. Bevan states that the percentage of purification effected is 93 per cent. on the albuminoid ammonia and 82 per cent. on the oxygen.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

See 14 (d) ante.

(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.

September 1898 and still going on.
Sundays. Bacteria beds, always resting.
Week days. Each bed filled once a day.

(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.

It has been noted that during the time sewage effluent was in contact with the filtering media in bacteria beds, temperature increased on an average 1 degree F. only (thermometer placed two feet below surface of bed)

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(18) Was any nuisance caused by the experimental works?	There is none. (Far less than on the land.)
(19) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	With pleasure any time.
(20) Give particulars of any other observations of importance which were recorded.	
(21) What inferences have been drawn from the experiment?	That it has been demonstrated beyond a doubt that open septic or detritus tanks with a capacity of not less than one day's dry weather flow with subsequent filtration through land laid out on the intermittent downward filtration principle and afterwards contact with bacteria will produce an effluent which is not injurious to fish life as the volume of the effluent is about 10 times the volume of the flow in the River Brent, into which it discharges, as for many weeks in the year the volume of water flowing in the River Brent is under 22,000 gallons, gauged by S.S. Grimley. It will be noted that the sewage is particularly foul, being little more than a solution of soap on three days a week, in addition to the dense domestic sewage on all days. A better effluent can be obtained from artificial bacteria beds than from the clay land forming the site of the outfall works.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	Quite practicable.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;	10*s*. per head first cost of bacteria beds in addition to the present open septic or detritus tanks.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	2*l*. 10*s*. to 3*l*. per million gallons of dry weather flow. If all the water were taken into account, the mean would be 25*s*. to 30*s*. per million gallons treated, but it is far better to take the cost on the dry weather flow. Let this be understood to be uniform throughout the replies, *i.e.*, cost to be given on the dry weather flow, which is the only reliable data.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

S. Slater Grimley,
Assoc. Member Inst. C.E.

Signature of Officer under whose direction the experiment was conducted.

Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS (SINGLE CONTACT).

Appendix 9C.

Name of authority - - - - - - - -	County Borough of West Bromwich.
Population of district - - - - - - - -	(1891). 59,489.
Water supply per head of the population - - -	20 gallons per day.
Estimated or measured dry weather flow of sewage -	About 400,000 gallons per day, high level sewage.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	None.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Wholly excluded.
Officer under whom the experiment has been conducted.	Borough engineer and surveyor.
Name and qualification of chemist who has made the analyses.	H. Silvester, F.I.C., F.C.S., borough analyst.

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	50,000 (25,000 each).
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	Two tanks, worked both in parallel and in series.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge? If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	Yes; one of the tanks was used only from October 3rd, 1899, to September 12th, 1900, it was then run out and about 100 cubic yards of sludge was found in it.
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	About 16,666 gallons, taking it at one-third of the capacity of bed.
(*b*) What was the depth of these beds?	3 feet.
(*c*) What were the nature and size of the filtering material?	Screened engine ashes ½-inch to 2-inch mesh.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	After the bed had worked twelve months, and had treated during that time 816 fillings, a meter was fixed at the outlet and readings taken.
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	9,950 gallons, average of twelve readings.
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material? (*b*) What was the depth of these beds? (*c*) What were the nature and size of the filtering material?	After the sewage had been treated in the coarse-grained beds it was passed on to the land which had been underdrained and took the place of fine-grained beds.
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(8) (*a*) What was the water-holding capacity of fine beds at end of experiment? (*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Three fillings every 24 hours, Sundays excepted, (*a*) 1½ hours, (*b*) 2 hours, (*c*) emptying, 1½ hours, resting 3 hours every 8 hours.
(10) State by what method the tank liquor was distributed on the beds.	By iron troughs.
(11) What was the average quantity of sewage in gallons dealt with daily?	Estimated at 45,000 gallons at commencement.
(12) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No. 1.
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.	Samples analysed at various dates between November, 1899, and September, 1900, 18 in all.
(14) Give (*a*) the average of the analyses of the final effluent from the beds	*See* following tables.

ANALYSES of SAMPLES of SEWAGE and EFFLUENTS after Bacteria Treatment from Friar Park Sewage Farm, West Bromwich, by H. Silvester, F.I.C., F.C.S., Borough Analyst.

(Quantities stated in parts per 100,000.)

HIGH LEVEL.

Date.	Sample No.	No. of filling.	CRUDE SEWAGE.							
			Chlorine.	Oxygen absorbed in 4 hours.	Nitrogen as Nitrites and Nitrates.	AMMONIA.		Solids in Solution.	Solids in Suspension.	Total Solids.
						Free.	Albuminoid.			
6 November -	*1	10	15·2	3·900	Nil	2·800	·500	80·0	2·4	82·4
14 ,, - -	*2	23	16·1	6·130	,,	5·400	1·220	100·0	6·0	106·0
22 ,, - -	3	40	27·3	4·108	,,	5·00	·610	120·0	43·2	163·2
29 ,, - -	4	58	23·5	6·550	,,	8·403	·950	129·0	102·0	231·0
19 December -	5	90	16·0	9·692	,,	6·360	1·325	126·0	79·6	205·6
9 January -	*6	134	8·5	·720	Traces	1·680	·092	91·0	4·0	95·0
16 ,, - -	7	154	13·0	2·590	Nil	2·820	·380	76·0	66·8	142·8
31 ,, - -	8	192	17·3	7·754	,,	6·440	·980	129·0	138·4	267·4
7 March -	9	258	23·0	3·806	,,	6·040	·454	114·5	73·8	188·3
21 ,, - -	10	292	10·4	2·313	,,	4·400	·330	73·0	76·4	149·4
29 ,, - -	11	312	7·3	1·541	,,	2·960	·198	57·0	25·0	82·0
6 April -	12	330	16·1	9·858	,,	7·112	·716	108·0	58·4	106·4
23 ,, - -	13	371	22·9	8·032	,,	8·824	·718	122·5	57·4	186·9
23 May -	14	445	16·9	3·718	,,	5·242	·584	95·4	81·2	176·6
29 June -	15	519	17·2	6·211	,,	5·022	·712	101·5	98·6	201·1
25 July -	16	581	11·6	4·700	,,	4·572	·630	82·0	45·0	127·0
30 August -	17	666	9·2	2·447	,,	2·612	·352	68·0	80·0	148·0
26 September -	18	731	16·0	6·553	,,	6·43	·528	92·0	59·2	151·2
Averages - -	—	—	15·97	5·034	—	5·118	·626	98·43	60·97	159·4

Date.	Sample No.	No. of filling.	EFFLUENT FROM COARSE BACTERIA BED.								
			Chlorine.	Oxygen absorbed in 4 hours.	Nitrogen as Nitrites and Nitrates.	AMMONIA.		Solids in Solution.	Solids in Suspension.	Total Solids.	Percentage of Purification.
						Free.	Albuminoid.				
6 November -	*1	10	18·8	1·740	—	1·300	·240	80·0	2·4	82·4	55·3
14 ,, - -	*2	23	18·4	1·240	Traces	2·210	·180	90·2	6·8	97·0	79·7
22 ,, - -	3	40	16·5	2·046	,,	3·000	·252	90·8	7·2	98·0	50·2
29 ,, - -	4	58	18·3	2·920	Nil	5·100	·492	107·0	20·0	127·0	55·4
19 December -	5	90	19·0	4·222	,,	5·650	·570	103·0	14·2	117·2	56·4
9 January -	*6	134	11·5	·980	Traces	2·400	·120	83·4	1·6	85·0	—
16 ,, - -	7	154	13·5	2·099	,,	2·400	·315	100·6	2·4	103·0	18·9
31 ,, - -	8	192	13·5	2·704	,,	3·908	·286	92·0	8·2	100·2	65·1
7 March -	9	258	13·0	1·482	,,	2·808	·278	88·0	4·64	92·64	61·0
21 ,, - -	10	292	12·5	2·226	,,	3·100	·320	85·4	3·8	89·2	3·7
29 ,, - -	11	312	15·8	2·758	,,	3·760	·348	86·6	6·4	93·0	—
6 April -	12	330	12·5	1·915	,,	2·880	·212	83·0	7·0	90·0	80·5
23 ,, - -	13	371	13·8	1·623	,,	3·363	·264	77·0	4·8	81·8	79·7
23 May -	14	445	17·1	2·276	,,	3·217	·268	89·8	6·4	96·2	38·7
29 June -	15	519	13·9	2·105	,,	3·280	·264	80·0	3·8	83·8	66·1
25 July -	16	581	12·5	2·140	,,	3·152	·224	85·0	3·1	88·1	54·4
30 August -	17	666	14·5	2·250	,,	3·640	·208	82·5	7·0	89·5	8·5
26 September -	18	731	15·3	2·258	,,	3·632	·284	78·0	6·68	84·68	65·5
Averages - -	—	—	15·02	2·165	—	3·266	·284	87·88	6·46	94·34	—

Date.	Sample No.	No. of filling.	EFFLUENT FROM LAND.									
			Chlorine.	Oxygen absorbed in 4 hours.	Nitrogen as Nitrites and Nitrates.	AMMONIA.		Solids in Solution.	Solids in Suspension.	Total Solids.	Percentage of Purification.	Total percentage of Purification.
						Free.	Albuminoid.					
6 November -	*1	10	10·6	·439	·846	·040	·040	83·0	None	83·0	74·7	88·7
14 ,, - -	*2	23	11·9	·738	1·354	1·000	·060	75·4	3·6	79·0	40·4	87·9
22 ,, - -	3	40	12·6	·283	1·323	·380	·058	67·0	2·4	69·4	86·1	93·1
29 ,, - -	4	58	12·3	·298	1·849	·280	·034	72·0	Traces	72·0	89·8	95·4
19 December -	5	90	17·2	·944	1·297	1·000	·085	92·0	,,	92·0	77·6	90·2
9 January -	*6	134	12·8	·222	1·333	·080	·035	82·0	,,	82·0	77·5	69·4
16 ,, - -	7	154	10·0	·432	1·547	·400	·048	74·8	1·20	76·0	79·5	83·3
31 ,, - -	8	192	14·4	·266	1·153	·084	·022	98·0	Traces	98·0	90·1	96·5
7 March -	9	258	15·0	·314	·930	·142	·040	98·0	Nil	98·0	78·8	94·4
21 ,, - -	10	292	10·6	·248	1·547	·156	·036	75·0	,,	75·0	88·8	89·2
29 ,, - -	11	312	8·75	·194	2·257	·224	·036	68·6	—	68·6	92·9	87·4
6 April -	12	330	11·0	·193	1·442	·116	·030	68·0	Nil	68·0	89·9	98·0
23 ,, - -	13	371	11·0	·146	1·384	·092	·036	74·0	,,	74·0	90·9	98·1
23 May -	14	445	9·5	·617	·570	·180	·056	82·7	Traces	82·7	72·8	83·4
29 June -	15	519	12·2	·282	·498	·444	·036	65·0	2·0	67·0	86·6	95·4
25 July -	16	581	21·4	·679	·689	·252	·064	106·0	Traces	106·9	68·2	85·5
30 August -	17	666	15·9	·181	·980	·032	·028	83·8	1·2	85·0	91·9	92·6
26 September -	18	731	11·9	·170	1·696	·042	·015	82·3	1·5	83·8	92·4	97·4
Averages - -	—	—	12·72	·369	1·260	·274	·042	80·4	·66	81·06	—	—

* Samples 1, 2, and 6 were taken after sewage had passed through detritus tanks, hence matter in suspension is low. Samples 6 and 11 dilute sewages, owing to heavy rainfall.

(*b*) the best analysis of the final effluent and date when sample was taken ; and	
(*c*) the worst analysis of the final effluent and date when sample was taken ;	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed ;	60·97 parts per 100,000.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible ?	·66 parts per 100,000.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	*See* foregoing tables.
(16) Between what dates was the experiment conducted ? If there were any periods of rest, state their duration.	Commenced 12th September, 1899, and extended to 1st November, 1900. Beds rested from 5th December to 12th December, 1899, and Sundays.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	

HIGH LEVEL (Cross-grained Bed).

—	Number of filling.	Time when Bed commenced to fill.	Time when filled.	Time when Valves opened to commence emptying.	Time when emptied.	Temperature of Sewage.	Temperature of Atmosphere before commencing to fill.	Temperature of Bed before commencing to fill.	Temperature of Bed when standing full for One Hour.	Temperature of Effluent.	Temperature of Bed immediately after emptying.
1899.											
December 13	74	1.0 a.m.	2.30 a.m.	4.30 a.m.	6.0 a.m.	51	33	48	50	50	49
„ 13	75	9.0 a.m.	10.15 a.m.	12.15 p.m.	1.45 p.m.	51	35	40	50	49	38
„ 13	76	4.45 p.m.	5.30 p.m.	7.30 p.m.	9.0 p.m.	49	29	39	48	47	46
„ 14	77	12.0 p.m.	1.30 a.m.	3.30 a.m.	5.0 a.m.	48	10	40	46	46	45
„ 14	78	8.0 a.m.	9.0 a.m.	11.0 a.m.	12.30 a.m.	49	13	34	49	49	42
„ 14	79	3.30 p.m.	4.45 p.m.	6.15 p.m.	8.15 p.m.	52	24	32	51	49	48
„ 15	80	11.15 p.m.	1.0 a.m.	3.0 a.m.	4.30 a.m.	49	26	42	47	46	45
„ 15	81	7.30 a.m.	9.0 a.m.	11.0 a.m.	12.30 a.m.	51	23	46	49	49	48
„ 15	82	3.30 p.m.	4.30 p.m.	6.30 p.m.	8.0 p.m.	51	20	49	46	49	47
„ 16	83	11.0 p.m.	12.30 a.m.	2.30 a.m.	4.0 a.m.	50	20	48	46	46	45
„ 16	84	7.0 a.m.	8.15 a.m.	10.15 a.m.	11.45 a.m.	51	20	40	50	50	47
„ 18	85	2.15 a.m.	4.0 a.m.	6.0 a.m.	7.30 a.m.	50	32	44	47	46	46
					Averages - -	50·17	23·75	41·91	48·25	48	45·5

(18) Was any nuisance caused by the experimental works ?	None whatever.
(19) Is the experiment still proceeding ?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so ?	Yes.
(20) Give particulars of any other observations of importance which were recorded.	*See* report enclosed.
(21) What inferences have been drawn from the experiment ?	*See* report enclosed.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	The scheme proposed by me, and lately adopted for the treatment of the whole of the sewage of the borough includes detritus or open septic tanks.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	About 5*s*.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	*See* answer to same question on Form L.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammonical nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Albert D. Greatorex, Assoc. M. Inst. C.E.,
Borough Engineer and Surveyor.
Signature of Officer under whose direction
the experiment was conducted.

Appendix 9C. Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority - - - - - - - -	Batley Corporation.
Population of district - - - - - - - -	30,000.
Water supply per head of the population - - -	For domestic purposes 12 gallons per day; for trade purposes 26 gallons per day.
Measured dry weather flow of sewage - - - -	500,020 gallons per day.
Is any trade refuse taken into the sewers? - - -	Yes, from wool washers, blanket makers, woollen manufacturers, dye works, carbonizers.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	About half the dry weather flow. *Note.*—There are very few water closets in this borough.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially.
Officer under whom the experiment has been conducted	Oscar J. Kirby.
Name and qualification of chemist who has made the analyses.	None made yet.
(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	240,000.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	Not worked in series.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	Yes.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	At the end of the first week 50,000 gallons of creamy sludge were let off from the bottoms of the tanks. This quantity was gradually reduced week by week for 15 weeks, since which (12 months, viz.:—January 13th, 1900) there has not been any sludge let off.
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	*Note.*—Two beds, 20 feet by 20 feet, and 3 feet 6 inches deep were put into use. Two months ago (November 9th), the high level bed has decreased in holding capacity from 38 per cent. to 27 per cent. And the low level bed from 38 per cent. to 33 per cent.
(*b*) What was the depth of these beds?	*See* above.
(*c*) What were the nature and size of the filtering material?	Furnace clinker broken to pass a 1½-inch screen, and rejected by ⅛-inch screen.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	The measurements were taken after resting in the ordinary way.
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and if so, what was the duration of the resting?	
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	The material is the same size in both beds.
(*b*) What was the depth of these beds?	
(*c*) What were the nature and size of the filtering material?	
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?	
(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	3 fillings a day. *a.* 2 hours filling. *b.* 2 hours standing full. *c.* 2 hours emptying. *d.* 2 hours resting.
(10) State by what method the tank liquor was distributed on the beds.	By distributing channels.

(11) What was the average quantity of sewage in gallons dealt with daily?	8,000 gallons.
(12) Was the quantity of sewage dealt with increased in time of storm?	No.
If so, state to what extent, and how the results were affected by such increase.	
(13) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to settle before being analysed.	
(14) Give (*a*) the average of the analyses of the final effluent from the beds;	*Note.*—Dr. M. Wilson, Chief Inspector of the West Riding Rivers Board, is by his staff about to make some analyses at these works, copies of which shall be sent on to the Commission.
(*b*) the best analysis of the final effluent and date when sample was taken; and	
(*c*) the worst analysis of the final effluent and date when sample was taken;	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed;	
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	No. They are not.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	
(16) Between what dates was the experiment conducted?	From November 9th to the present date.
If there were any periods of rest, state their duration.	The beds rest all day on Sundays.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	None made.
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes, certainly.
(20) Give particulars of any other observations of importance which were recorded.	
(21) What inferences have been drawn from the experiment?	The following, viz. :—As the final effluent is only slightly cloudy (after standing 12 hours it is quite bright), and has no tendency to secondary putrefaction, it is quite possible to purify sewage containing a substantial proportion of trades wastes, by open septic tanks and double contact beds.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	Yes.
(*a*) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers	Ten shillings.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	Eight pence.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

O. J. KIRBY,
Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority	Borough of Guildford.
Population of district	17,000.
Water supply per head of the population	30 gallons per day. This quantity includes the supply of water to the railway authorities, but for which the supply per head of population would not greatly exceed 20 gallons.
Estimated or measured dry weather flow of sewage	480,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	The refuse from three breweries approximately one-third the dry weather flow.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Only partially excluded.
Officer under whom the experiment has been conducted	
Name and qualification of chemist who has made the analyses.	
(1) (a) What is the capacity in gallons of the open septic tank or tanks.	148,000.
(b) If there was more than one tank, state whether they were worked in series or in parallel.	One only in use at present.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge.	Weekly observations have been made.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	No sludge has yet been removed, and although at least 50,000,000 gallons of sewage has passed through this tank, the solids at the bottom average only 14 inches deep, whilst the scum on the top is 25 inches thick.
(3) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	25,000 gallons per bed, which multiplied by 5 (the number of beds) gives 125,000 gallons dealt with in each working.
(b) What was the depth of these beds?	Two feet nine inches.
(c) What were the nature and size of the filtering material?	Burnt ballast and clinker rejected by a ½-inch mesh screen, the material after screening to pass through a 3-inch ring.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No measurements have been taken, but very little difference in the water capacity of the coarse beds has been observed since the filters were first used, now some eight months ago.
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	
(6) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(b) What was the depth of these beds?	2 ft. 6 in.
(c) What were the nature and size of the filtering material?	Burnt ballast and clinker which passed a ½-in. mesh, but was rejected by a $\frac{1}{16}$-inch mesh, dust to be carefully excluded.
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(8) (a) What was the water-holding capacity of fine beds at end of experiment?	No material difference has been noticed in respect to the fine beds consisting of burnt ballast, but the clinker beds have made up somewhat during the six months they have been in use, which in my opinion is due to the fact that the dust was not carefully excluded.
(b) Was this measurement made after resting, and, if so, what was the duration of the resting?	

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying and (*e*) resting.	Two fillings in the 24 hours as follows:— Filling - - 1 to $1\frac{1}{2}$ hours. Standing full - 2 hours. Emptying - 1 to $1\frac{1}{2}$ hours. Resting - - 2 hours.
(10) State by what method the tank liquor was distributed on the beds.	Simply allowed to run on the beds through tren[illegible] into the media.
(11) What was the average quantity of sewage in gallons dealt with daily?	250,000 gallons.
(12) Was the quantity of sewage dealt with increased in time of storm?	No.
If so, state to what extent, and how the results were affected by such increase.	
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.	The only analysis yet made was through the kindness of the Borough Engineer of Croydon, who was interested in the percentage of purification at once observable by the sewage passing through scum tank. I submit herewith a copy of same, in which it will be noticed an excellent effluent is obtained by intermittent filtration of the effluent from the second contact beds through an experimental tertiary bed, consisting of sand or dust excluded in the sieving of the media for the second or fine beds.

CROYDON CORPORATION, BEDDINGTON FARM,
December 10th, 1900.

THOS. WALKER, Esq., C.E., Borough Engineer.

Dear Sir,—The following are the results of analyses of samples received from the Borough Engineer of Guildford. I received them on the 6th inst., and they are marked as taken on the 4th.

SEWAGE.

Oxygen absorbed, 15 mins.	8·48 grains per gallon.
„ „ 4 hours	17·03 „ „
Chlorine	9·0 „ „
Ammonia, free	115·28 parts per million.
„ Albuminoid	35·77 „ „
Appearance	Opaque; very dark colour; large amount of suspended matter.

EFFLUENT, OPEN SEPTIC TANK.

Oxygen absorbed, 15 mins.	2·92 grains per gallon.
„ „ 4 hours	7·17 „ „
Chlorine	6·1 „ „
Ammonia, free	77·70 parts per million.
„ Albuminoid	11·72 „ „
Appearance	Opaque; offensive smell; fair amount of matter in suspension.

EFFLUENT, COARSE CONTACT BED.—Two hours' contact.

Oxygen absorbed, 15 mins.	1·66 grains per gallon
„ „ 4 hours	3·32 „ „
Chlorine	8·0 „ „
Ammonia, free	64·08 parts per million
„ Albuminoid	9·11 „ „
Appearance	Opaque; offensive smell.

EFFLUENT, FINE CONTACT BED.—Two hours' contact.

Oxygen absorbed, 15 mins.	0·20 grains per gallon.
„ „ 4 hours	0·43 „ „
Chlorine	8·0 „ „
Ammonia, free	43·77 parts per million.
„ Albuminoid	1·60 „ „
Appearance	Faint smell; large amount of suspended matter for an effluent.

EFFLUENT, EXPERIMENTAL.—THIRD CONTACT BED.

Chlorine	4·1 grains per gallon.
Ammonia, free	0·07 parts per million.
„ Albuminoid	0·19 „ „
Appearance	Bright and clear; free from smell.

EFFLUENT. FINAL FROM LAND.

Oxygen absorbed, 15 mins.	0·27 grains per gallon.
„ „ 4 hours	0·65 „ „
Chlorine	6·9 „ „
Ammonia, free	32·14 parts per million.
„ Albuminoid	1·30 „ „
Appearance	Opaque; large amount of suspended matter for an effluent. Large trace of ferrous iron in suspended matter.

Yours faithfully,
(Signed) JOHN E. FARMER,
Analyst.

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.	
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	
(15) Give a typical analysis of the crude sewage to which the experiment relates.	It may be explained here that exactly one-half of the dry weather flow is dealt with on bacteriological lines, the remaining portion being treated with chemicals, the solids pumped on to some land and ploughed in, whilst the top water is run through coke filters on the intermittent continuous process, and then run on to the land.
(16) Between what dates was the experiment conducted?	
If there were any periods of rest, state their duration.	
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	

Appendix 9C.

(18) Was any nuisance caused by the experimental works?	Complaints were received during the hot days in August last, relative to a smell arising from the scum on top of open septic tank, and it was deemed advisable to temporarily cover the same with tarpaulins which have since been removed.
(19) Is the experiment still proceeding? - - - If so, may the Commission inspect the works, should they deem it desirable to do so?	Certainly if the Commission deem the works worthy of a visit which should be shortly if they wish to see the open septic in use after over 300 days work, as the necessity of cleaning the tank out will have to be considered at no distant date as the depth of the solids at bottom, and the scum on the surface continues to increase, and it is now 50 per cent. of the cubical contents of the tank.
(20) Give particulars of any other observations of importance which were recorded.	
(21) What inferences have been drawn from the experiment?	That it is absolutely necessary to have an intercepting tank between the outfall and the primary or coarse beds, in order to intercept the silt and grease which otherwise would in a very short space of time cause the beds to lose a high percentage of their efficiency by the surface becoming clogged, which under present conditions of working seems to form one of the chief difficulties to be overcome in the bacteriological treatment of sewage without some form of precipitation being first undertaken.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	The dry weather flow is only considered in the undermentioned replies, as the conditions vary so much in respect to the wet weather flow in this town.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	About 1*l*. per head of the population.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	About 6*d*. per head, which should be still further reduced if the final treatment was by tertiary artificial beds, instead of land treatment. The foregoing approximate estimate does not allow for the periodical replacement of filtering media in the beds, but a sufficient area of artificial beds is included to allow for each filter being alternately rested until again fit for use.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Total organic nitrogen.

C. G. Mason, Borough Surveyor.
Signature of Officer under whose direction the experiment was conducted.

Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority	Heywood Corporation.
Population of district	26,000.
Water supply per head of the population	20 gallons per day.
Estimated or measured dry weather flow of sewage	800,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Partly from breweries and dye works. About 5 per cent.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted	Sewage works manager.
Name and qualification of chemist who has made the analyses.	Joshua Bolton (advan.) S.K.
(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	3,600.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	Yes.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	After 6 months about 5-inch deposit on bottom of tank
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	42 per cent.
(*b*) What was the depth of these beds?	3 feet.
(*c*) What were the nature and size of the filtering material?	Passed 3-inch mesh; rejected by 1-inch mesh.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	Measurement taken after 6 months working about $\frac{1}{3}$ capacity, no special period of rest given.
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	About $\frac{1}{3}$.
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material:	39 per cent.
(*b*) What was the depth of these beds?	3 feet.
(*c*) What were the nature and size of the filtering material?	Passed a 1-inch mesh; rejected by $\frac{1}{4}$-inch.
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	Measurement taken after 6 months working, then about $\frac{1}{3}$ capacity, no special period of rest given.
(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?	34 per cent.
(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?	Taken under ordinary conditions, no special resting period.
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	$3\frac{1}{2}$ per 24 hours. $1\frac{1}{2}$ hours filling, 2 hours full. $\frac{1}{2}$ hour emptying and 3 hours resting
(10) State by what method the tank liquor was distributed on the beds.	Troughs.
(11) What was the average quantity of sewage in gallons dealt with daily?	220 gallons per square yard.

Appendix 9C.

(12) Was the quantity of sewage dealt with increased in time of storm?	Slightly.
If so, state to what extent, and how the results were affected by such increase.	Good results.
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.	Daily. Bottle shaken.
(14) Give (*a*) the average of the analyses of the final effluent from the beds.	Oxygen absorbed in 4 hours - - - - - - 1·0 Chlorine - - - - - - - - - 5·9 Free ammonia - - - - - - - - ·60 Albuminoid ammonia - - - - - - - ·12 N as nitrites ·71. - - - - - - - ·71 N as nitrites not estimated.
(*b*) the best analysis of the final effluent and date when sample was taken, and	(*b*) September 28th, 1900. Oxygen absorbed 4 hours - - - - - - 0·32 Chlorine - - - - - - - - 2·90 Free ammonia - - - - - - - 0·28 Albuminoid ammonia - - - - - - - 0·07 Nitrates - - - - - - - - - 1·10
(*c*) the worst analysis of the final effluent and date when sample was taken.	(*c*) September 11th, 1900. Oxygen absorbed 4 hours - - - - - - 2·7 Chlorine - - - - - - - - 9·0 Free ammonia - - - - - - - 0·57 Albuminoid ammonia - - - - - - - 0·12 Nitrates trace.
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.	Not estimated.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Traces, non-putrescible.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	Average of many samples. Oxygen absorbed in 4 hours - - - - - 7·7 Chlorine - - - - - - - - - 5·9 Free ammonia - - - - - - - 2·10 Albuminoid ammonia - - - - - - - 0·51 Nitrates nil.
(16) Between what dates was the experiment conducted?	June 1st, 1900, to present date.
If there were any periods of rest, state their duration	1 day per week.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	Mean about 51° F.
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding? - - - -	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(20) Give particulars of any other observations of importance which were recorded.	Good results continuously. Only slight deposit on the beds, which have not been raked since experiments commenced.
(21) What inferences have been drawn from the experiment?	That the sewage of Heywood can be cheaply and effectively purified by the agency of bacteria, in open tanks and double contact beds.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	Not estimated.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	8*d*. per head.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

JOSHUA BOLTON.

Signature of Officer under whose direction the experiment was conducted.

Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS (DOUBLE CONTACT.)

Appendix 9C.

Name of authority	Huddersfield Corporation.
Population of district	105,000.
Water supply per head of the population	14 for domestic purposes, 9 for trade purposes } gallons per day.
Estimated or measured dry weather flow of sewage	Measured 7,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes, a large quantity, chiefly from the scouring, dyeing and finishing of wool, &c.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	29 per cent. of dry weather flow.
Is the storm, soil or surface water, wholly or partially excluded from the ordinary sewers?	A large quantity of storm and surface water enters the sewers.
Officer under whom the experiment has been conducted	Borough Engineer.
Name and qualification of chemist who has made the analyses.	Percy Coward.

(1) (*a*) What is the capacity in gallons of the open septic tanks or tank?

One tank, [illegible]5,000 gallons capacity.

(*b*) If there was more than one tank, state whether they were worked in series or in parallel.

(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?

Yes.

If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.

No sludge has as yet been removed from the septic tank. The tank was put into operation on 23rd July 1900, and on 7th January 1900 its condition was as follows:

	Ft.	in.
Depth of clear liquid	4	3
Depth of sludge (at foot)	1	3
Total depth	5	6

(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?

3,987 gallons.

(*b*) What was the depth of these beds?

3 ft. 9 in.

(*c*) What were the nature and size of the filtering material?

Top 3 in., clinker $\frac{3}{16}$ in. to $\frac{1}{2}$ in.
Top 3 ft. 6 in., clinker 1 in. to 3 in.

(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.

Date.	Capacity.	Previous Rest.
	Gallons.	
22nd August 1900	3,987	Initial capacity.
24th September 1900	2,956	3 hours.
13th November 1900	2,730	3 "
14th January 1901	2,520	3 "

(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?

The experiment is still proceeding.

(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

After the coarse and fine beds had been in operation a few days, the contents of the coarse filled the fine so as to leave about $\frac{1}{2}$ in. of liquid above the material of the bed. Initial capacity, therefore, about 3,900 gallons.

(*b*) What was the depth of these beds?

3 ft. 9 in.

(*c*) What were the nature and size of the filtering material?

Top layer 3 in., clinker $\frac{3}{16}$ in. to $\frac{1}{2}$ in.
" 3·6 in. " $\frac{3}{16}$ in. to 1 in.

(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

None made.

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(8) (a) What was the water-holding capacity of fine beds at end of experiment?

Experiment still proceeding.

(b) Was this measurement made after resting, and, if so, what was the duration of the resting?

Experiment still proceeding.

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (a) filling, (b) standing full, (c) emptying, and (e) resting.

Filled three times per day.

—	Coarse Bed.	Fine Bed.
(a) - - - - -	3 hours	3 hours.
(b) - - - - -	7 "	6 "
(c) - - - - -	3 "	3 "
(e) - - - - -	9 "	12 "

(10) State by what method the tank liquor was distributed on the beds.

It is not distributed on the beds, but allowed to flow on at one point.

(11) What was the average quantity of sewage in gallons dealt with daily?

Tank - - 55,000 gallons per day.
Beds - - 7,100 " "

(12) Was the quantity of sewage dealt with increased in time of storm?

If so, state to what extent, and how the results were affected by such increase.

Not increased.

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.

Samples are analysed daily. Neither filtered through paper nor allowed to settle before being analysed.

(14) Give (a) the average of the analyses of the final effluent from the beds.

Nitrous and nitric nitrogen -	·043	(8 weeks' average).
Ammoniacal nitrogen - -	·55	(19 " "
Albuminoid nitrogen - -	·123	(19 " "
Oxygen absorbed in four hours at 80° Fahr. - - - -	1·97	(19 " "
Oxygen absorbed in three minutes - - - -	·77	(19 " "

(b) the best analysis of the final effluent and date when sample was taken, and

(c) the worst analysis of the final effluent and date when sample was taken.

—	(b) 31st Dec. 1900.	(c) 21st Sept. 1900.
Ammoniacal nitrogen - -	·73	·09
Albuminoid nitrogen - -	·196	·046
Oxygen absorbed in four hours at 80° Fahr. - -	3·86	·69
Oxygen absorbed in three minutes - - - -	1·46	·21

(d) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.

Solids suspended:

Mineral - -	3·4
Volatile - -	6·6
Total - -	10·0

(e) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Only traces present.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

Nitrous and nitric nitrogen - - - -	·031
Ammoniacal nitrogen - - - - -	1·02
Albuminoid nitrogen - - - - - -	·459
Oxygen absorbed in four hours at 80° Fahr.:	
Sample shaken - - - - - - -	9·20
" settled - - - - - - -	7·09
Oxygen absorbed in three minutes - -	3·01

Reaction—Slightly alkaline to litmus.

Solids:

In suspension:	
Mineral - -	9·3
Volatile - -	20·3
Total - -	29·6
In solution:	
Mineral - -	58·2
Volatile - -	12·2
Total - -	70·4
Total solids:	
Mineral - -	67·5
Volatile - -	32·5
Total - -	100·0

(16) Between what dates was the experiment conducted?

Experiment commenced August 24th, 1900, and still being conducted.

If there were any periods of rest, state their duration.

The tank works continuously. The beds rest on Sundays. Both the tank and the beds rested one week in October 1900.

(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.

No observations have been made.

(18) Was any nuisance caused by the experimental works?

No.

(19) Is the experiment still proceeding?

Yes.

If so, may the Commission inspect the works, should they deem it desirable to do so?

Yes.

(20) Give particulars of any other observations of importance which were recorded.

As yet no permanent scum has formed upon the surface of the septic tank, the wind and rain beating the sludge, which is buoyed to the surface by the gas evolved, down again. An energetic action, however, takes place even in the coldest weather.

It has been noticed that the amount of solid matter in suspension increased as the septic action became more energetic, as the following results show:

—	Suspended Solids in Septic Effluent.		
	Mineral.	Volatile.	Total.
Average for the 2 weeks ended 5th Sept. 1900	1·4	5·2	6·6
4 ,, ,, 3rd Oct. ,,	2·9	5·3	8·2
4 ,, ,, 31st Oct. ,,	3·8	7·5	11·3
4 ,, ,, 28th Nov. ,,	4·3	7·9	12·2
4 ,, ,, 26th Dec. ,,	4·6	7·1	11·7

(21) What inferences have been drawn from the experiment?

Before any definite opinion can be formed of the open septic tank and double contact system, it will be necessary to have further experience, as it has, with the exception of the first few weeks at the commencement of the trial, been limited to the cold and wet months.

(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state.

Practicable to adopt the system.

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.

1*l*. 15*s*. 5*d*.

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.

6*s*. 7*d*.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

J. L. Campbell, M.Inst. C.E.

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS.

(Southern Outfall. Coke-bed fed with sewage which had been passed through an open septic tank.)

Name of authority	London County Council.
Population of district	1,678,104 (1896). (Sewage derived from London South of Thames.)
Water supply per head of the population	34·8 gallons per day (1900).
Estimated or measured dry weather flow of sewage	About 90,000,000 gallons per day.
Is any trade refuse taken into the sewers?	All the trade refuse from the districts drained is taken into the sewers.
If so, state from what processes it is derived, and approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	The quantity of trade refuse is not known.
Is the storm, soil or surface water, wholly or partially excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted.	Dr. Clowes.
Name and qualification of chemist who has made the analyses.	Mr. J. W. H. Biggs.

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	9,000.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	Only one tank.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	Yes.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	The sludge has not been removed. After about five months work the liquid was drained off. The tank then contained 19 inches of sludge, containing 87·8 per cent. of moisture. The dried sludge contained 68 per cent. of inorganic matter, not removable by ignition in air. 67·1 per cent. of the suspended putrescible matter in the sewage was liquefied by septic action.
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	2,750 gallons.
(*b*) What was the depth of these beds?	6 feet
(*c*) What were the nature and size of the filtering material?	Coke which passed through a 2-inch mesh, and which was rejected by a 1-inch mesh.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	(see table below)

Date.	Gallons.	Remarks.
5 Nov. 1900	2,750	An old coke-bed was used which had been working only four days with the septic effluent.
6 Dec. „	2,550	
9 Jan. 1901	2,150	
21 Jan. „	2,100	
7 March „	2,600	The bed had been resting from January 22nd.
1 May „	2,475	
12 June „	2,300	
21 Aug. „	2,200	
5 Oct. „	2,175	

(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	2,175 gallons. After about one day's rest.
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	No fine beds were used.
(*b*) What was the depth of these beds?	
(*c*) What were the nature and size of the filtering material?	
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	

Appendix 9C.

(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?

(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

Normally, four fillings per day. (*a*) $\frac{1}{2}$ hour filling; (*b*) 2 hours standing full; (*c*) 1 hour emptying, $2\frac{1}{2}$ hours resting. When the full number of fillings was impossible the resting periods were correspondingly increased.

(10) State by what method the tank liquor was distributed on the beds.

By splashing from distributing pipes upon perforated wooden trays.

(11) What was the average quantity of sewage in gallons dealt with daily?

While four fillings per day were made, 43,200 gallons passed through the septic tank in 24 hours. But 36,000 gallons represents the average flow, owing to the reduced number of fillings during part of the period.

(12) Was the quantity of sewage dealt with increased in time of storm?

If so, state to what extent, and how the results were affected by such increase.

The experimental plant was not affected by storm water.

(13) State at what intervals analyses of the final effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.

Samples taken every $\frac{1}{4}$ hour, and average daily sample taken for analysis. The sample was filtered for all estimations except in the case of the estimations of oxygen absorbed by the total solids.

(14) Give (*a*) the average of the analyses of the final effluent from the beds;

—	No. 1 Bed.	No. 2 Bed.
Oxygen absorbed from permanganate in four hours at 80° F.:		
By the total putrescible matter.	2·445	2·456
By the dissolved putrescible matter.	1·850	1·765
Nitrous nitrogen - - -	0·0757	0·0740
Nitric nitrogen - - - -	0·0492	0·0703

(*b*) the best analysis of the final effluent and date when sample was taken; and

31st December 1900.

(*c*) the worst analysis of the final effluent and date when sample was taken.

16th January 1901.

—	(*b*)	(*c*)
Oxygen absorbed from permanganate in four hours at 80° F.:		
By the total putrescible matter.	1·474	5·876
By the dissolved putrescible matter.	1·158	5·051
Nitrous nitrogen - - -	0·250	0·044
Nitric nitrogen - - - -	0·137	0·077
Albuminoid nitrogen - -	0·154	0·410

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed;

13·6 parts per 100,000.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Suspended solids were not estimated. The final effluent was not putrescible in an incubator at 80° F.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

Average for the whole period, 5th November 1900—4th October 1901:—

Oxygen absorbed from permanganate in four hours at 80° F	
By the total putrescible matter - -	5·936
By the dissolved putrescible matter - -	4·088
Nitrous nitrogen - - - - - - -	0·0005
Nitric nitrogen - - - - - - -	Nil.
Suspended solids - - - - - - -	26·5

(16) Between what dates was the experiment conducted?

5th November 1900—4th October 1901.

If there were any periods of rest, state their duration

Septic tank, Sundays; 27 other days at various times.
Coke-beds, Sundays; 11 other days at various times.

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(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	Not taken
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding? - - - -	No.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(20) Give particulars of any other observations of importance which were recorded.	
(21) What inferences have been drawn from the experiment?	
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	This system appears perfectly practicable, and a non-putrescible effluent of satisfactory character would b obtained by its adoption. A somewhat heavy expenditure would be incurred by pumping the effluen into the river during high water.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

FRANK CLOWES,
Chief Chemist to the London County Council.
Signature of Officer under whose direction the experiment was conducted.

Form B

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS.

Beds A. and B. working in conjunction.

Name of authority	Manchester.
Population of district	550,000.
Water supply per head of the population	28 gallons per day : domestic, 17, trade, 11.
Estimated or measured dry weather flow of sewage	27,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Breweries, dye and bleach works, galvanising works, grease refineries, tanneries, manufactories of tar products, rubber goods works, tripe-dressing works, and mineral water manufactories. 4 to 5 per cent.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enter the sewers. Storm overflows are provided at certain points, which are supposed to come into action at a dilution of 5 to 1. In certain cases, however, they fail to answer their purpose.
Officer under whom the experiment has been conducted	Gilbert J. Fowler, M.Sc., F.I.C., Superintendent Chemist. W. Clifford, A.R.C. Sc.I. (Nov. 1898—Nov. 1899.) E. Ardern, B.Sc. (Vict.) (Nov. 1899.) H. D. Bell, A. Oddie, E. Hadfield, } Junior Assistants.
Name and qualification of chemist who has made the analyses.	Under direction of G. J. Fowler.

(1) (a) What is the capacity in gallons of the open septic tank or tanks.

,125,000.

(b) If there was more than one tank, state whether they were worked in series or in parallel.

(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?

If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.

(3) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?

(b) What was the depth of these beds?

3 feet.

(c) What was the nature and size of the filtering material?

Bed A.—Screened clinker. Rough material round the drain pipes, otherwise material uniform round the bed, which has passed 3-inch mesh, and rejected by 1-inch.

(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.

Date.	Capacity in Gallons.	Remarks.
13th April 1899	3,020	After 3½ hours rest.
20th ,, ,,	3,350	,, ,,

What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and if so, what was the duration of the resting?

(6) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

(b) What was the depth of these beds?

3 feet.

(c) What was the nature and size of the filterin material?

Bed B. Screened clinker. Rough clinker round the drain pipes. Otherwise material uniform throughout the bed. Passed 1-inch mesh, rejected by ¼-inch.

(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not

Date.	Capacity in Gallons.	Remarks.
13th April 1899	4,000	2½ hours draining.
20th ,, ,,	4,350	,,

Appendix 9C.

Question	Answer
(8) (a) What was the water-holding capacity of fine beds at end of experiment?	
(b) Was this measurement made after resting, and, if so, what was the duration of the resting?	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (a) filling, (b) standing full, (c) emptying, and (e) resting.	During this period the beds were filled 4 times each day, Sundays excepted. Cycle: (a) ¼ hour; (b) 2 hours; (c) ¼ hour; (e) 3½ hours. The contents of Bed A being, in each case, run on to Bed B.
(10) State by what method the tank liquor was distributed on the beds.	By means of wooden shoots, laid on the surface of the bed, perforated at the bottom of the sides.
(11) What was the average quantity of sewage in gallons dealt with daily?	11,550 (allowing for Sunday's rest).
(12) Was the quantity of sewage dealt with increased in time of storm?	No.
If so, state to what extent, and how the results were affected by such increase.	
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.	Daily, except Sundays. Samples shaken before analysis.
(14) Give (a) the average of the analyses of the final effluent from the beds.	The following numbers are the average of daily analyses of final effluent (B).

Four Hours' Oxygen Absorption.	Incubator Test. 3 mins. Oxygen Absorption.		Putresci-bility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
	Before.	After.						
1·71	·67	·74	21/62	1·25	·13	·008	·189	15·0

Question	Answer
(b) the best analysis of the final effluent and date when sample was taken; and	
(c) the worst analysis of the final effluent and date when sample was taken;	
(d) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed;	
(e) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Slight.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	The average of daily analyses of Settled Sewage during the month of May 1899 is as follows: 4 hours' oxygen absorption - - - 5·99 3 minutes' oxygen absorption - - - 3·37 Ammoniacal nitrogen - - - - 2·33 Albuminoid nitrogen - - - - ·324 Chlorine - - - - - - - - 16·0
(16) Between what dates was the experiment conducted?	27th April and 26th May, 1899.
If there were any periods of rest, state their duration.	Rested on Sundays, no other rest.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding?	
If so, may the Commission inspect the works, should they deem it desirable to do so?	No.
(20) Give particulars of any other observations of importance which were recorded.	Most of the unsatisfactory results obtained occurred during the first fortnight, the later results being much more satisfactory.

(21) What inferences have been drawn from the experiment?	The above observations would point to the fact that a bed which is accustomed to receiving settled sewage will not satisfactorily purify septic tank effluent without some period being allowed for its adjustment to the altered conditions. It is important, therefore, that beds should not be used indiscriminately for fresh or septicised sewage.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal —excluding the cost of land and cost of sewers;	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system --excluding the annual repayment of any loan.	

Appendix 9C

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANKS AND CONTACT BEDS.

Beds C and D working in conjunction.

Name of authority - - - - - - - -	Manchester.
Population of district - - - - - - -	
Water supply per head of the population - - -	
Estimated or measured dry weather flow of sewage -	
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse	
Is the storm, soil, or surface water, wholly or partially, excluded from the ordinary sewers?	
Officer under whom the experiment has been conducted	
Name and qualification of chemist who has made the analyses.	

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?

1,125,000.

(*b*) If there was more than one tank, state whether they were worked in series or in parallel.

(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?

If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.

(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?

(*b*) What was the depth of these beds?

3 feet.

(*c*) What was the nature and size of the filtering material?

Bed C. Screened clinker. Rough material round the pipes. Material uniform throughout the beds. Passed $\frac{3}{4}$-inch, rejected by $\frac{1}{4}$-inch mesh.

(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.

Date.	Capacity in Gallons.	Remarks.
5th July, 1899	3,690	4 hours rest
17th August, "	3,250	4 "

(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?

(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

(*b*) What was the depth of these beds?

3 feet.

(*c*) What was the nature and size of the filtering material?

Screened clinker. Rough material round the drainage pipes, otherwise uniform throughout the bed Passed $\frac{1}{2}$-inch mesh, and rejected by $\frac{1}{8}$-inch.

(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?

(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*), emptying, and (*e*) resting.

Date.	No. of fillings per day.	Time of filling.
June 1st to 7th - -	2	
June 8th to July 5th -	3	
July 5th to Aug. 16th	4	

Cycle in general: (*a*) $\frac{1}{4}$, (*b*) 2 hours, (*c*) $\frac{1}{2}$, (*e*) remainder of time according to the number of fillings, the contents of Bed C being in each case run on to Bed D.

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(10) State by what method the tank liquor was distributed on the beds.	By means of wooden shoots laid on the bed, perforated at the bottom of the sides.
(11) What was the average quantity of sewage in gallons dealt with daily?	10,510 gallons per day (allowing for Sunday's rest).
(12) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No.
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.	Daily except Sundays. Samples shaken before analysis.
(14) Give (*a*) the average of the analyses of the final effluent from the beds;	The following numbers are the average of daily analyses of the final filtrate (from Bed D) for the periods given:—

Date.	Four Hours' Oxygen Absorption.	Incubator Test—3 min. Oxygen Absorption.		Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
		Before.	After.						
1899.									
Jan. 1—7 - - - - (2 fillings per day.)	·74	·27	·23	0—12	·40	·07	·088	·617	14·0
June 8—July 6 - - (3 fillings per day.)	·71	·33	·23	0—71	·39	·067	·081	·614	16·1
July 6—August 16 - (4 fillings per day.)	·71	·36	·29	0—54	·44	·054	·071	·728	15·7

(*b*) the best analysis of the final effluent and date when sample was taken; and (*c*) the worst analysis of the final effluent and date when sample was taken. (*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed. (*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Practically nil.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	The following numbers are the average of daily analyses of settled sewage from June 2nd to August 16th, 1899: 4 hours oxygen absorption - - - - - 6.54 3 minutes „ - - - - - 3·80 Ammoniacal nitrogen - - - - - 2·47 Albuminoid nitrogen - - - - - ·37 Chlorine - - - - - - - - - 16·1
(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	June 1st to August 17th, 1899. Rested on Sundays, no other rest.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding? If so, may the Commission inspect the works, should they deem it desirable to do so?	No.
(20) Give particulars of any other observations of importance which were recorded.	
(21) What inferences have been drawn from the experiment?	The chemical efficiency of the bed appears to increase as time goes on, the results from four fillings per day being even better than the earlier results with two fillings.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state (*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers; (*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Total organic nitrogen.

GILBERT J. FOWLER,
Signature of Officer under whose direction the experiment was conducted.

Form B.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS.

Bed A (Single Contact).

Name of authority	Manchester.
Population of district	
Water supply per head of the population	
Estimated or measured dry weather flow of sewage	
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	
Officer under whom the experiment has been conducted	
Name and qualification of chemist who has made the analyses.	

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	1,125,000 gallons.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	
Were any observations made as to the filling up of the septic tanks by deposit of sludge?	
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	3 feet.
(*c*) What was the nature and size of the filtering material?	Bed A. (after replacement).—Screened clinker. Rough clinker round the drainage pipes. 2 ft. 9 in. passed $\frac{3}{4}$-in. mesh, and rejected by $\frac{1}{8}$-in. 3 inches at top of fine material.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	See table below.

BED A.

Date.	Capacity in Gallons.	Remarks.
31st Aug. 1899	4,200	Bed A opened up on 2nd June and material taken out and broken down; exposed for two months. Replaced on 22nd August, and worked with 2 fillings per day. Measurement made after 4 hours' rest.
20th Sept. "	3,930	After 4 hours' draining.

(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	
(*c*) What was the nature and size of the filtering material?	

Appendix 9C.

( ) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?	
(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	See table below.

Date.	No. of Fillings per Day.	Time of Filling.
26th—31st August 1899	2	12.15 p.m. and 6 p.m.
1st—13th Sept. ,,	3	6.30 a.m., 12.30 p.m., and 6.30 p.m.
Cycle: (*a*) ¼ hr., (*b*) 2 hrs.	(*c*) ¼ hr.	(*e*) Remainder of time, according to the number of fillings.

(10) State by what method the tank liquor was distributed on the beds.	By means of wooden shoots, perforated at the bottom of the sides.
(11) What was the average quantity of sewage in gallons dealt with daily?	9,500 gallons (allowing for Sunday's rest).
(12) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No.
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.	Daily, except Sundays. Samples shaken before analysis.
(14) Give (*a*) the average of the analyses of the final effluent from the beds.	The following numbers are the average of daily analyses of the filtrate from Bed A for the periods given:—

Date.	Four Hours' Oxygen Absorption.	Incubator Test, 3 min. Oxygen Absorption. Before.	Incubator Test, 3 min. Oxygen Absorption. After.	Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
23rd—31st August (2 fillings per day.)	2·48	1·37	1·43	1·5	1·17	·09	·176	* ·576	14·1
1st—13th September (3 fillings per day.)	2·28	1·11	1·03	3·11	1·27	·135	·034	·107	15·4

* High nitrate number for this period due to the fact that the bed had been resting for some time prior to this experiment.

(*b*) the best analysis of the final effluent and date when sample was taken, and	
(*c*) the worst analysis of the final effluent and date when sample was taken.	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.	
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Small amount.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	The following numbers are the average of daily analyses of *Settled Sewage* from 17th August—13th September, 1898:—

4 hrs. oxygen absorption - -	6·43
3 min. ,, ,, - -	3·64
Ammoniacal nitrogen - -	2·28
Albuminoid ,, -	·294
Chlorine - - -	16·0

Appendix 9C.

(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	26th August—13th September 1899. Bed rested on Sundays.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding? - - - If so, may the Commission inspect the works, should they deem it desirable to do so?	No.
(20) Give particulars of any other observations of importance which were recorded.	
(21) What inferences have been drawn from the experiment?	
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	
(*b*) What would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Signature of Officer under whose direction the experiment was conducted.

Form B.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS.

Bed C (primary) worked in conjunction with Beds B and D (secondary).

Name of authority	Manchester.
Population of district	
Water supply per head of the population	
Estimated or measured dry weather flow of sewage	
Is any trade refuse taken into the sewers? If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	
Officer under whom the experiment has been conducted.	
Name and qualification of chemist who has made the analyses.	
(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	1,125,000.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel?	
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge? If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	
(*b*) What was the depth of this bed?	3 feet.
(*c*) What was the nature and size of the filtering material?	Bed C.—Screened clinker. Except rough clinker round the drainage pipes, material uniform throughout the bed: to pass ¾ in. mesh and rejected by ¼ in.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of primary bed, stating in each case whether the measurement was made after resting or not.	(see table below)

Date.	Capacity in Gallons.	Remarks.
1899.		
August 17th	3,250	After 4 hours rest.
September 14th	1,965	„ 1¼ „
„ 15th	2,220	„ 3½ „

(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	3 feet.
(*c*) What was the nature and size of the filtering material?	Bed B.—Screened clinker; to pass 1 in. mesh and rejected by ¼ in. Bed D.—Screened clinker; to pass ½ in. mesh and rejected by ⅛ in. In each rough clinker placed round the drainage pipes.
(7) Give particulars of measurements made from time to time during the experiments of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	(see table below)

Bed B.

Date.	Capacity in Gallons.	Remarks.
6 September 1899	3,680	After 7 days rest.
„ „	3,050	„ 1¼ hours draining.

Appendix 9C.

(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?

(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

Eight fillings per day on Bed C, four of which were run to B bed and four on to Bed D. Cycle for primary bed—(*a*) ¼ hour, (*b*) 1 hour, (*c*) ½ hour, (*e*) 1¼ hour. Cycle for secondary beds—(*a*) ½ hour, (*b*) 2 hours, (*c*) ½ hour, (*e*) 3 hours.

(10) State by what method the tank liquor was distributed on the beds.

By means of wooden shoots (perforated at the bottom of sides) laid on the surface of the beds.

(11) What was the average quantity of sewage in gallons dealt with daily?

33,600 gallons per day, after allowing for Sunday's rest.

(12) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.

Daily, except Sundays. Samples shaken before analysis.

(14) Give (*a*) the average of the analyses of the final effluent from the beds.

The following numbers are the average of daily analyses of the final filtrate—(*a*) from bed B, (*b*) from bed D:—

—	Four Hours' Oxygen Absorption.	Incubator Test—3 min. Oxygen Absorption. Before.	Incubator Test—3 min. Oxygen Absorption. After.	Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
(*a*) Bed B filtrate -	·88	·41	·34	0—24	·78	·066	·039	·713	15·5
(*b*) Bed D filtrate -	·66	·31	·25	0—24	·39	·049	·034	·93	15·6

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken.

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.

(*e*) the average of the estimations made of the solids in suspension in the final effluent Were these putrescible?

Practically nil.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily analyses of *Settled Sewage* from August 17th to September 13th, 1899:—

4 hours oxygen absorption - -	6·43
3 mins. ,, ,, - -	3·64
Ammoniacal nitrogen - - -	2·28
Albuminoid nitrogen - - -	·294
Chlorine - - - - -	16·0

(16) Between what dates was the experiment conducted?

August 17th—September 15th, 1899.

If there were any periods of rest, state their duration

Beds rested on Sundays only.

(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.

(18) Was any nuisance caused by the experimental works?

No.

(19) Is the experiment still proceeding?

No.

If so, may the Commission inspect the works, should they deem it desirable to do so?

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(20) Give particulars of any other observations of importance which were recorded.

Although the purification effected was quite satisfactory, the capacity of the primary bed rapidly diminished. This loss of capacity was, however, largely recovered after a few weeks rest, viz. :

Date.	Capacity in Gallons.	Remarks.
September 26th -	3,520	After 11 days rest.
,, ,, -	3,200	,, 3½ hours draining.
October 4th - -	3,650	,, further rest of 8 days.
,, - -	3,320	,, 3½ hours draining.

(21) What inferences have been drawn from the experiment?

Eight fillings per day are evidently in excess of what the primary bed can take for a prolonged period. Should it be necessary, however, on a special occasion to work the bed to this extent, it does not appear that permanent injury will result.

(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.

(b) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C.

Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS.

Beds A (primary) and B (secondary) in conjunction.

Name of authority - - - - - - - -	Manchester.
Population of district - - - - - - -	
Water supply per head of the population - - -	
Estimated or measured dry weather flow of sewage -	
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	
Officer under whom the experiment has been conducted	
Name and qualification of chemist who has made the analyses?	

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks? — 1,125,000 gallons.

(*b*) If there was more than one tank, state whether they were worked in series or in parallel.

(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?

If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.

(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?

(*b*) What was the depth of this bed? - - - — 3 feet.

(*c*) What was the nature and size of the filtering material? — A Bed.—Screened clinker. Rough material round the drainage pipes, 2 ft. 9 in., to pass $\frac{3}{4}$ in. and rejected by $\frac{1}{8}$ in. mesh; 3 in. top layer of fine material.

(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of primary beds, stating in each case whether the measurement was made after resting or not.

Date.	Capacity in Gallons.	Remarks.
20th September 1899 -	3,930	After $4\frac{1}{2}$ hrs. draining.
21st „ „ -	3,520	„ $1\frac{1}{4}$ „ „

(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?

(6) (*a*) What was the water-holding capacity at commencement of experiment of the secondary beds when filled with the filtering material?

(*b*) What was the depth of this bed? - - - — 3 feet.

(*c*) What was the nature and size of the filtering material? — Bed B.—Screened clinker. Except for rough clinker round the drainage pipes, material uniform throughout the bed. To pass 1 in. mesh, and rejected by $\frac{1}{4}$ in. mesh.

(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the secondary beds, stating in each case whether measurement was made after resting or not.

Date.	Capacity in Gallons.	Remarks.
22nd September 1899 -	4,470	After $3\frac{1}{2}$ hrs. draining.
25th „ „ -	4,480	, $3\frac{1}{2}$ „
5th October „ -	4,590	$3\frac{1}{2}$

Appendix 9C.

(8) (a) What was the water-holding capacity of fine beds at end of experiment?	
(b) Was this measurement made after resting, and, if so, what was the duration of the resting?	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (a) filling, (b) standing full, (c) emptying, and (e) resting.	Bed A (primary) filled four times per day. Cycle: (a) $\frac{1}{4}$; (b) 2 hrs.; (c) $\frac{1}{2}$ hr.; (e) $3\frac{1}{4}$ hrs. Contents of Bed A in each case being run on to bed B, and operation repeated.
(10) State by what method the tank liquor was distributed on the beds.	By means of wooden shoots laid on the surface of the bed.
(11) What was the average quantity of sewage in gallons dealt with daily?	12·635 (allowing for Sunday's rest).
(12) Was the quantity of sewage dealt with increased in time of storm?	No.
If so, state to what extent, and how the results were affected by such increase.	
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.	Daily, except Sundays. Samples shaken before analysis.
(14) Give (a) the average of the analyses of the final effluent from the beds.	The following numbers are the average of daily analyses of filtrate from the secondary bed B:—

Four Hours' Oxygen Absorption.	Incubator Test, 3 Min. Oxygen Absorption.		Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
	Before.	After.						
·76	·33	·27	0—17	·37	·048	·037	·951	14·0

(b) the best analysis of the final effluent and date when sample was taken, and	
(c) the worst analysis of the final effluent and date when sample was taken.	
(d) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.	
(e) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Very small amount.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	The following numbers are the average of daily analyses of *Settled Sewage* from 16th September—14th October, 1899:— Four hrs. oxygen absorption - - 5·77 Three min. „ „ - - 2·94 Ammoniacal nitrate - - - - - 1·80 Albuminoid „ - - - - - ·276 Chlorine - - - - - - - 13·9
(16) Between what dates was the experiment conducted?	16th September—14th October (inclusive) 1899.
If there were any periods of rest, state their duration.	Beds rested on Sundays only.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	
(18) Was any nuisance caused by the experimental works	No

Appendix 9C.

(19) Is the experiment still proceeding? - - -	No
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(20) Give particulars of any other observations of importance which were recorded.	In this experiment the filtrates from the primary bed were in every case non-putrefactive
(21) What inferences have been drawn from the experiment?	
(22 If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Signature of Officer under whose direction the experiment was conducted.

orm B.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS.

Bed B (Single contact).

Name of authority - - - - - -	Manchester.
Population of district - - - - - - -	
Water supply per head of the population - - -	
Estimated or measured dry weather flow of sewage - -	
Is any trade refuse taken into the sewers?	
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse?	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	
Officer under whom the experiment has been conducted	
Name and qualification of chemist who has made the analyses.	

(1) (a) What is the capacity in gallons of the open septic tank or tanks? — 1,125,000 gallons.

(b) If there was more than one tank, state whether they were worked in series or in parallel.

(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?

If the sludge was removed from the septic tanks, state how often this was done, and, approximately, what quantity of sludge was removed on each occasion.

(3) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material? — 3 feet.

(b) What was the depth of the bed?

(c) What was the nature and size of the filtering material? — Bed B.—Screened Clinker.—With the exception of rough material round the drain pipes, material uniform throughout the bed. To pass 1-inch mesh, and be rejected by $\frac{1}{4}$-inch mesh.

(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of bed, stating in each case whether the measurement was made after resting or not.

Bed B.

Date.	Capacity in Gallons.	Remarks.
1899:		
5 October - -	4,590	$3\frac{1}{2}$ hours' draining.
7 November - -	3,730	$3\frac{1}{2}$ " "
8 December - -	3,510	$17\frac{1}{2}$ " "
	3,130	$\frac{3}{4}$ " "
	3,100	$\frac{3}{4}$ " "
1900:		
27 February - -	3,300	4 days' rest.
27 February - -	3,030	$1\frac{1}{2}$ hours' drain ng.

(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?

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(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

(*b*) What was the depth of these beds?

(*c*) What was the nature and size of the filtering material?

(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?

(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

4 fillings per day, as follows:—
5th October–7th December 1899, 6 hour cycle: (*a*) $\frac{1}{4}$ hour; (*b*) 2 hours; (*c*) $\frac{1}{2}$ hour; (*e*) $3\frac{1}{4}$ hours.
7th December 1899–22nd February 1900, 3 short cycles and one long cycle: (*a*) $\frac{1}{4}$ hour; (*b*) 1 hour; (*c*) $\frac{1}{2}$ hour; (*e*) $\frac{3}{4}$ hour; (3 times); (*a*) $\frac{1}{4}$ hour; (*b*) 1 hour; (*c*) $\frac{1}{2}$ hour; (*e*) $14\frac{3}{4}$ hours.

(10) State by what method the tank liquor was distributed on the beds.

By means of wooden shoots laid on the surface of the bed.

(11) What was the average quantity of sewage in gallons dealt with daily?

12,100 (after allowing for periods of rest).

(12) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(13) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to settle before being analysed.

Daily, except Sundays. Samples shaken before analysis.

(14) Give (*a*) the average of the analyses of the final effluent from the beds;

The following numbers are the average of daily analyses of the filtrate from Bed B. during the two periods of work:—
i., 4 cycles of 6 hours; *ii.*, 4 cycles in 10 hours, and 14 hours' rest.

—	Four Hours' Oxygen Absorption.	Incubator Test. 3 mins'. Oxygen Absorption. Before.	After.	Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
i. 5 Oct.–7 Dec. -	2·07	1·03	1·06	16–54	1·20	·105	·039	·187	15·1
i. 7 Dec.–22 Feb. -	1·59	·81	·63	$16\frac{1}{2}$–101	1·06	·082	·024	·447	14·6

(*b*) the best analysis of the final effluent and date when sample was taken; and

(*c*) the worst analysis of the final effluent and date when sample was taken;

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed;

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Small amount.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily analyses of *Settled Sewage* for the 6 months ending 28th March 1900.

4 hours oxygen absorption - - - -	7·23
3 mins. oxygen absorption - - -	3·70
Ammoniacal nitrogen - - - - -	2·21
Albuminoid nitrogen - - - - -	·306
Chlorine - - - - - - -	16·1

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(16) Between what dates was the experiment conducted?	5th October 1899 to 22nd February 1900.
If there were any periods of rest, state their duration.	Beds rested on Sundays and on 8th December 1899.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding?	No.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(20) Give particulars of any other observations of importance which were recorded.	
(21) What inferences have been drawn from the experiment?	The experiment shews that the purification effected by the bed is equally good, whether the fillings are distrbiuted equally over the whole of the 24 hours, or whether all take place in a short time, thus allowing a correspondingly longer period of rest at one time. Thus it is evidently possible to increase the rate of working of a bed for a short time, provided it has an equivalent period of rest, without any detrimental effect. The measurements of capacity shew that it is not advisable to work a bed on four fillings per day for a long period of time, without intervals of rest of some duration.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state.	
(*a*) What would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	
(*b*) What would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nirrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Signature of Officer under whose direction
the experiment was conducted.

Appendix 9C. Form B

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS.

Bed B (single contact).

Name of authority	Manchester.
Population of district	
Water supply per head of the population	
Estimated or measured dry weather flow of sewage	
Is any trade refuse taken into the sewers?	
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	
Officer under whom the experiment has been conducted	
Name and qualification of chemist who has made the analyses.	

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?

1,125,000 gallons.

(*b*) If there was more than one tank, state whether they were worked in series or in parallel?

(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?

If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.

(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?

(*b*) What was the depth of this bed?

3 feet.

(*c*) What was the nature and size of the filtering material?

Bed B.

Screened Clinker:

With the exception of rough clinker round the drainage pipes, material uniform throughout the bed. To pass 1-inch and be rejected by ¼-inch mesh. On 13th July, the top 3 inches of material were removed and replaced by material formerly on Bed D. (To pass ½-inch and rejected by ⅛th-inch mesh).

(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of bed, stating in each case whether the measurement was made after resting or not.

Bed B.

Date.	Capacity in gallons.	Remarks.
1900.		
7 May - -	3,400	13 days rest (rain prior to measurement).
7 May - -	3,080	4½ hours draining.
14 June - -	3,620	7 days rest.
14 June - -	3,200	1¼ hour draining.
12 July - -	4,150	7 days rest.
12 July - -	3,510	1¼ hour draining.
2 Aug. - -	3,220	17 hours draining.
2 Aug. -	2,980	1¼ hour draining.
9 Aug. -	3,540	7 days rest (wet weather).
9 Aug. -	3,010	1¼ hour draining (rain in meantime).
6 Sept. -	3,680	7 days rest.
6 Sept. -	3,050	1¼ hours draining.
4 Oct. - -	3,520	7 days rest (very wet weather).
4 Oct. - -	2,810	1¼ hours draining (very wet weather).
31 Oct. - -	2,680	1¼ hour draining.
8 Nov. -	3,310	7 days rest.
8 Nov. -	2,780	1¼ hours draining.

(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and if so, what was the duration of the resting

(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

(*b*) What was the depth of these beds?

(*c*) What was the nature and size of the filtering material?

(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether the measurement was made after resting or not

(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?

(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

1900, May 8th–June 6th.—2 fillings per day. Cycles: (*a*) $\frac{1}{2}$ hour, (*b*) $\frac{3}{4}$ hour, (*c*) $\frac{1}{2}$ hour, (*e*) $\frac{3}{4}$ hours; (*a*) $\frac{1}{2}$ hour, (*b*) $\frac{3}{4}$ hour, (*c*) $\frac{1}{2}$ hour, (*e*) $19\frac{3}{4}$ hours.
1900, June 13th–December 26th.—3 fillings per day. Cycles: (*a*) $\frac{1}{2}$ hour, (*b*) $\frac{3}{4}$ hour, (*c*) $\frac{1}{2}$ hour, (*e*) $\frac{3}{4}$ hour; (*a*) $\frac{1}{2}$ hour, (*b*) $\frac{3}{4}$ hour, (*c*) $\frac{1}{2}$ hour, (*e*) $\frac{3}{4}$ hour; (*a*) $\frac{1}{2}$ hour, (*b*) $\frac{3}{4}$ hour, (*c*) $\frac{1}{2}$ hour, (*e*) $17\frac{1}{4}$ hours.

(10) State by what method the tank liquor was distributed on the beds.

By means of shallow grips cut in the surface of the bed.

(11) What was the average quantity of sewage in gallons dealt with daily?

7,000 (allowing for all periods of rest).

(12) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.

Daily, except Sundays. Samples shaken before analysis.

(14) Give (*a*) the average of the analyses of the final effluent from the beds;

The following numbers are the average of daily analyses of filtrate from Bed B. for the two periods given:—

Date.	Four Hours' Oxygen Absorption.	Incubator Test. 3 mins. Oxygen Absorption.		Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
		Before.	After.						
1900. May 8th–June 6th (2 fillings per day).	3·16	1·77	1·45	5–37	1·20	·193	·089	·606	15·8
June 13th–Dec. 26th (3 fillings per day).	2·50	1·33	1·17	$27\frac{1}{2}$–124	1·13	·176	·035	·494	15·8

(*b*) the best analysis of the final effluent and date when sample was taken; and

(*c*) the worst analysis of the final effluent and date when sample was taken;

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed;

Average of 75 determinations from August 2nd, 1900–January 24th, 1901 = 16·0 parts per 100,000.

Maximum - - - 27·1 parts per 100,000.
Minimum - - - 4·6 „ „

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Small amount.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily analyses of crude sewage for the half-year ending December 26th:—

4 hours oxygen absorption - - - -	11·11
3 minutes oxygen absorption - - - -	5·49
Ammoniacal nitrogen - - -	2·23
Albuminoid nitrogen - - - -	·59
Chlorine - - - - - - - -	17·0

(16) Between what dates was the experiment conducted?

Commenced May 8th, 1900, still proceeding. Results given up to December 26th, 1900.

If there were any periods of rest, state their duration.

Bed B rested on Sundays, and in general one week in four. Total rest = 80 days.

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(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(20) Give particulars of any other observations of importance which were recorded.	It is noticeable that the efficiency of purification increased as time went on. During the quarter ending 26th December, 1900, practically all the samples were non-putrefactive. It must be remarked that the open septic tank was restarted about the commencement of this experiment, the bed thus receiving practically fresh sewage for the first two months or so, as the septic action had not attained its full development. When this was attained, the purity of the filtrate increased.
(21) What inferences have been drawn from the experiment?	With thoroughly septicised effluent it is possible to purify to an adequate extent 534,000 gallons per acre per day, on beds 3 feet deep, without loss of capacity.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Signature of Officer under whose direction the experiment was conducted.

Form B.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS.

Beds A and C (primary) worked in conjunction with bed D (secondary)

Name of authority - - - - - - - -	Manchester.
Population of district - - - - - - -	
Water supply per head of the population	
Estimated or measured dry weather flow of sewage- -	
Is any trade refuse taken into the sewers? - - -	
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	
Officer under whom the experiment has been conducted.	
Name and qualification of chemist who has made the analyses.	

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	1,125,000.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	
(3) (*a*) What was the water-holding capacity at commencement of experiment of the primary beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	3 feet.
(*c*) What was the nature and size of the filterin material?	Screened Clinker Bed A. Rough clinker round the drainage pipes, 2 feet 9-in. To pass $\frac{3}{4}$-in., and rejected by $\frac{1}{8}$-in., 3-in. top layer of fine material. Bed C. With exception of roug clinker round the pipes, material uniform throug out the bed. To pa $\frac{3}{4}$-in. mesh, and rejecte by $\frac{1}{4}$-in.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	

Bed A. Date.	Bed A. Capacity in Gallons.	Bed A. Remarks.	Bed C. Date.	Bed C. Capacity in Gallons.	Bed C. Remarks.
November 2nd, 1899	2,960	3 hours draining.	October 4th, 1899	3,320	$3\frac{1}{2}$ hours draining.
December 10th, ,,	2,590	3 ,, ,,	November 4th, 1900	2,700	3 ,, ,,
,, 21st, ,,	2,690	$\frac{1}{2}$,, ,,	March 6th, 1900	1,840	$3\frac{1}{2}$,, ,,
,, 22nd, ,,	2,860	3 ,, ,,	,, 12th, ,,	1,980	$4\frac{1}{2}$,, ,,
March 2nd, 1900	1,940	3 ,, ,,	April 3rd, ,,	1,570	$4\frac{1}{2}$,, ,,
,, 5th, ,,	2,700	2 days rest.	April 12th, ,,	2,720	15 days rest.
,, 5th, ,,	2,190	$3\frac{1}{2}$ hours draining	,, 19th, ,,	2,[illegible]00	$3\frac{1}{2}$ hours draining.
April 11th, ,,	1.480	$4\frac{1}{2}$,, ,,			
,, 25th, ,,	2,610	14 days rest.			
,, 25th, ,,	2,060	$3\frac{1}{2}$ hours draining.			

NOTE. The last two capacity measurements for beds A and C are given to shew the increase after prolonged rest. They are not included in subsequent calculations of work done.

(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	

Appendix 9C.

(6) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

(b) What was the depth of this bed?

At commencement 3 feet. Reduced to 2 feet by removal of top foot on March 22nd, 1900.

(c) What was the nature and size of the filtering material?

Bed D. Screened clinker. With the exception of rough clinker round the drainage pipes, material uniform throughout the bed. To pass $\frac{1}{2}$-in. and rejected by $\frac{1}{8}$-in. mesh.

(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not?

BED D.

Date.	Capacity in Gallons.	Remarks.
September 19th	3,410	After 1 hour's draining.
November [illegible]th	3,960	„ 1 day's rest.

(8) (a) What was the water-holding capacity of fine beds at end of experiment?

(b) Was this measurement made after resting, and, if so, what was the duration of the resting?

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (a) filling, (b) standing full, (c) emptying, and (e) resting.

Four fillings per day each on the primary beds A and C, Cycle, (a) $\frac{1}{4}$ hour, (b) 2 hours, (c) $\frac{1}{2}$ hour, (e) $3\frac{1}{4}$ hours. Secondary bed D received the contents from each primary bed. Cycle, (a) $\frac{1}{2}$ hour, (b) 1 hour, (c) $\frac{1}{2}$ hour, (e) 1 hour.

(10) State by what method the tank liquor was distributed on the beds.

By means of wooden shoots laid on the surface of the beds; the shoots were perforated at the bottom of the sides.

(11) What was the average quantity of sewage in gallons dealt with daily?

15,180 gallons per day (allowing for all rests).

(12) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.

Daily except Sundays. Samples shaken before analysis.

(14) Give (a) the average of the analyses of the final effluent from the beds;

The following numbers are the average of daily analyses of filtrates (*i.*) Primary Bed A, (*ii.*) Primary Bed C. and (*iii.*) Secondary Bed D.

	Four Hours Oxygen Absorption.	Incubator Test. 3 mins. Oxygen Absorption. Before.	After.	Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
i. Filtrates from Bed A	2·01	10.1	·91	35—156	1·09	·101	·026	·27	15·3
ii. „ „ „ C	1·90	·89	·80	19—137	1·10	·104	·020	·285	15·4
iii. „ „ „ D	·67	·31	·23	0—293	·49	·041	·020	·838	15·0

(b) the best analysis of the final effluent and date when sample was taken; and

(c) the worst analysis of the final effluent and date when sample was taken;

(d) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed;

(e) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Practically nil.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily analyses of *Settled Sewage* for the six months ending March 8th, 1900.

Four Hours Oxygen Absorption.	Three Minutes Oxygen Absorption.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Chlorine.
7·20	3·70	2·12	·366	16·1

Appendix 9C.

(16) Between what dates was the experiment conducted?	October 5th, 1899-April 11th, 1900.
If there were any periods of rest, state their duration.	Beds rested on Sundays. Also Bed A from December 11th-14th, 1899 (inclusive) and Bed C from April 4th-11th, 1900 (inclusive).
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding?	No.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(20) Give particulars of any other observations of importance which were recorded.	On March 22nd the top foot of material from the secondary bed D was taken off. Owing partly, perhaps, to disturbance of the surface, an accumulation of fine material took place round the drainage pipes, thus impeding the drainage. On this account and also probably from the removal of the upper nitrifying layer, the bed at the end of the experiment ceased to give such satisfactory results, although all samples were non-putrefactive. The whole of the results are included in the average. Since this experiment the bed D has been opened, the drainage pipes put right, and the bed re-worked with as good results as ever. Attention may be drawn to the fact that the percentage reduction in capacity of the primary beds is considerably less than in a former experiment, when one primary bed was worked in conjunction with two secondary ones. The composition of the final filtrate obtained was practically identical in the two experiments. The above reduction in capacity was to a large extent recovered by a fortnight's rest in the early summer.
(21) What inferences have been drawn from the experiment?	It is evident from this and former experiments that it is not necessary to have an equal area of primary and secondary beds in order to produce a satisfactory filtrate. It is also clear that the reduction is made with the greatest advantage in the area of the secondary beds. The measurements of capacity shew that it is not advisable to work primary beds for a prolonged period of time on four fillings per day, without intervals of rest of some duration.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers,	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual payment of any loan.	

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C.

Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS.

Primary Beds B and C working in conjunction with secondary Bed D.

Name of authority - - - - - - - -	Manchester.
Population of district - - - - - - -	
Water supply per head of the population - - -	
Estimated or measured dry weather flow of sewage -	
Is any trade refuse taken into the sewers? If so, state from what process it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	
Officer under whom the experiment has been conducted	
Name and qualification of chemist who has made the analyses.	

(1) (*a*) What is the capacity in gallons of the open peptic tank or tanks?	
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge? If the sludge was removed from the septic tanks, state how often this was done, and approximately, what quantity of sludge was removed on each occasion.	
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	3 feet.
(*c*) What was the nature and size of the filtering material?	**Bed A.** / **Bed C.** Both rough material round the drain pipes. 2 ft. 9 in. Material otherwise uniform. Bed A: To pass $\frac{3}{4}$-in. and rejected by $\frac{1}{8}$-in. 3-in. top layer of fine material. Bed C: To pass $\frac{3}{4}$-in. and rejected by $\frac{1}{4}$-in.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of primary beds, stating in each case whether the measurement was made after resting or not.	

BED A.

Date.	Capacity in gallons.	Remarks.
1900:		
May 4th - - - -	2,600	22 days rest
	2,330	$4\frac{1}{2}$ hours draining.
June 7th - - - -	2,490	6 " " (after week's rest)
July 5th - - - -	2,660	7 days rest.
" 6th, - - - -	2 280	$7\frac{1}{2}$ hours draining.
August 3rd - - -	2,170	6 " "
" 30th - - -	2,950	7 days rest.
" 31st - - -	2,450	6 hours draining.
September 17th - -	3,060	8 days rest.
" 27th - -	2,660	After a further rest of 10 days, 1 filling and 6 hours draining.
October 15th - - -	2,330	6 hours draining.
" 16th - - -	2,270	2 " " wet weather.
	2,200	4 " " wet weather.
	2.050	2 " " wet weather.
" 25th - - -	2,690	7 days rest—very wet.
" 26th - - -	2,430	6 hours draining.
November 10th - -	2,830	7 days rest.

BED C.

Date.	Capacity in gallons.	Remarks
1900:		
May 1st - - -	3,100	27 days rest.
" 24th - - -	2,460	$3\frac{1}{2}$ hours draining.
" 31st - - -	2,440	16 " "
June 1st - - -	3.010	7 days rest.
" 28th - - -	2,580	6 hours draining.
" 29th - - -	3,020	7 days rest.
July 26th - - -	2,480	6 hours draining.
" 27th - - -	3,360	7 days rest.
August 23rd - -	2,610	6 hours draining.
" 27th : -	3,100	7 days rest.
September 11th -	2,740	6 hours rest.
" 18th -	2,940	2 days rest
" 28th -	3,200	9 " "
November 1st - -	2,740	6 hours draining.
" 9th - -	2,610	6 " wet weather.
	3,130	6 days rest.

(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	

Appendix 9C.

(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

(*b*) What was the depth of these beds? - - - -

2 feet.

(*c*) What was the nature and size of the filtering material?

Bed D. Screened Clinker. With the exception of rough material round the drain pipes, material uniform throughout the bed. To pass ½-in. and rejected by ⅛-in. mesh.

(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

Bed D.

Date.	Capacity in Gallons.	Remarks.
1900.		
May 17th ...	2,380	2 hours draining.
September 10th	2,220	1 day's rest.
„ 17th	1,880	2½ hours draining.
„ 24th	2,530	8 days rest.
	2,570	15 days rest. (Wet weather).

(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?

(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

1900.—May 3rd to May 31st, 2 fillings per day.
(*a*) at 12 noon and 6 p.m.
(*c*) at 9 a.m. and 3 p.m.

1900.—June 1st to December 26th, 3 fillings per day.
(*a*) at 5 a.m., 1 p.m. and 9 p.m.
(*c*) at 9 a.m., 5 p.m. and 1 a.m.

Cycle, (*a*) ½ hour; (*b*) 1 hour; (*c*) ½ hour; (*e*) rest of time according to number of fillings.

The primary beds were given one week's rest in four. In each case the filtrates from Beds A and C are discharged on to beds and given an hour's contact.

(10) State by what method the tank liquor was distributed on the beds.

At commencement by means of wooden shoots laid on the surface of the bed.

On November 12th these shoots were removed in the case of the primary beds A. and C, and shallow grips cut in their place, in the surface of the bed.

(11) What was the average quantity of sewage in gallons dealt with daily?

9,000. (Allowing for all periods of rest).

(12) Was the quantity of sewage dealt with increased in time of storm?

An extra filling was occasionally put on the beds, at times of heavy flow, without any detrimental effect.

If so, state to what extent, and how the results were affected by such increase.

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.

Daily, except Sundays. Samples shaken before analysis.

(14) Give (*a*) the average of the analyses of the final effluent from the beds;

The following numbers are the average of daily analyses of the filtrate from primary Beds A and C, and secondary Bed D for the two periods given:—

1900.	Beds.	Four Hours Oxygen Absorption.	Incubator Test—3 mins. Oxygen Absorption.		Putrecibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chorline.
			Before.	After.						
March 3—31 - -	A.	2·48	1·31	·94	1½-37	·70	·13	·06	1·08	15·8
(2 fillings per day)	C.	2·15	1·10	·64	1½-36	·72	·14	·06	1·28	15·4
	D. (final effluent)	·81	·34	·27	0-75	·55	·073	·033	1·43*	15·1
June 1—Dec. 26 -	A.	2·30	1·20	1·21	39½-122	·82	·172	·034	·50	15·6
(3 fillings per day)	C.	2·04	1 04	·96	28-127	·75	·157	·03	·58	5 8
	D. (final filtrate)	·79	·34	·26	0-182	·235	·066	·027	1 04	15·4

* High nitrate numbers for this period, due largely to prolonged period of rest, just prior to the commencement of this experiment.

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(*b*) the best analysis of the final effluent and date when sample was taken ; and	
(*c*) the worst analysis of the final effluent and date when sample was taken ;	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed ;	Average of 75 determinations from August 2nd, 1900, to January 24th, 1901 = 16·0 parts per 100,000. Maximum - - - 27·1 parts per 100,000. Minimum - - - 4·6 " " "
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Practically nil. No.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	The following numbers are the average of daily analyses of *Crude Sewage* for the half-year ending December 26th, 1900 : 4 hours xoygen absorption - - - 11·11 3 minutes oxygen absorption - - - 5·49 Ammoniacal nitrogen - - - - 2·23 Albuminoid nitrogen - - - - - ·59 Chlorine - - - - - - - - 17·0
(16) Between what dates was the experiment conducted?	Commenced May 3rd, 1900, results given up to December 26th, 1900. Experiment proceeding.
If there were any periods of rest, state their duration.	Primary beds A and C given one week's rest in four. Beds A, C and D rested on Sundays. Total rests Beds A, and C = 91 days each. (Including Sundays) Bed D = 45 days.
(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.	
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding? - - - -	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(20) Give particulars of any other observations of importance which were recorded.	Measurements of capacity of the primary beds made during this experiment shew that there was practically no reduction in capacity ; it must be borne in mind that during a considerable part of the experiment it was summer time. Recent measurements have shewn that during the winter months the capacity is not so well maintained, but it has never been so low as at the end of the period preceding this experiment. The surface of the beds required very little attention.
(21) What inferences have been drawn from the experiment?	Primary beds in Manchester may be safely worked on three fillings per day of septic tank effluent, with one week's rest in four, together with Sundays. Any decrease of capacity during the winter may probably be largely recovered by an extra week's rest in the summer. It is possible to effectively distribute the tank effluent on the beds by simply cutting shallow grips in the surface.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers?	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan?	

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

GILBERT J. FOWLER.
Signature of Officer under whose direction the experiment was conducted.

Form B. Appendix 9 C

GENERAL OBSERVATIONS.—MANCHESTER.

SLUDGE REMOVED FROM THE OPEN SEPTIC TANK.

The open septic tank was first emptied on April 26th, 1900; it had then been working almost exactly fourteen months, having been started on February 24th, 1899.

The average daily rate of flow during that time was approximately 2,000,000 gallons.

Besides the suspended matter contained in the ordinary sewage, several hundred barrow loads of garbage were tipped into the tank.

The amount of sludge remaining in the tank at the end of the above period of working amounted in bulk to 4,000 tons of 90 per cent. sludge, but as in this case only 84 per cent. of moisture was present the actual weight of sludge would be greater than the above figure.

It was concluded from the above experiment that from 50 to 60 per cent. of the sludge which would otherwise accumulate had disappeared.

No exact estimate of the amount of sludge actually destroyed was possible from the data available, and it should be noted that a considerable amount of suspended matter passed away in the tank effluent.

Recent more exact experiments have shown that with a tank space equal to half the daily flow of Manchester sewage, it is possible when the tank is in full working order to destroy about one-third of the total suspended matter in the sewage.

The percentage destruction is, however, much less during the earlier periods of working; it is important, therefore, when it is necessary to remove the sludge that this should be done, as far as possible, without interfering with the septic action.

A tank arranged for this purpose is in process of construction.

Character of the Septic Tank Effluent.

(i.) Experiment has shewn that the effluents from the closed and open septic tanks are practically identical in composition.

(ii.) The suspended matter in the septic tank effluent is of a granular character and readily separates out on standing, and when arrested on the surface of a bacteria bed does not seriously impede the free flow of the water into the bed.

(iii.) The organic matter in solution is much more easily nitrified than that at present in fresh sewage, so that it is possible with one contact to constantly obtain non-putrefactive filtrates; in the case of raw and settled sewage this is seldom the case.

(iv.) The blending which takes place in the septic tank is of value in minimising the effect of excessive amounts of manufacturing refuse, and in producing an effluent of fairly constant composition.

Capacity of Beds.

(i.) There is rapid initial decrease in the capacity of the beds; this is manifestly due in part to the consolidation of the material of the bed.

(ii.) After this initial decrease it has been found possible by allowing suitable periods of rests, to maintain a capacity equal to from 25 to 33 per cent. of the empty capacity of the bed for a considerable period of time. The capacity appears to be best maintained if it is never allowed to decrease below a certain limit before rest; frequent short periods of rest, say, of three days or a week, are better than long periods of the same total duration.

Recovery of capacity does not take place to an equal extent when the bed is rested during the winter months as is the case in the summer. It appears probable that any decrease in capacity in the winter, excluding the initial period above referred to, may be more than recovered during the summer.

Labour on the Beds.

During the earlier period of working very little labour is required and after two years raking the surface about once a month appears to be all that is necessary.

Method of working Beds.

It has been established beyond doubt that one secondary bed can safely receive the filtrate from two primary beds.

Distribution of tank effluent on the bed can be simply effected by means of shallow grips cut in the surface.

The primary beds may safely receive three fillings of septic tank effluent per day, when ten days rest in twenty-eight are allowed.

Four fillings a day can be effectively purified by the beds, but the capacity figures in this case show more rapid decrease. An occasional extra filling in time of storm can however be put upon the beds without any apparent detriment.

With regard to the cycle of operations, experiment has shown that the purification effected depends rather upon the amount of tank effluent dealt with per given area, than upon the length of cycle employed. Two short cycles and one long one in the twenty-four hours giving results equal to, if not better than three cycles of equal duration. Variations in the rate of flow can thus be dealt with and in cases of large increases of flow, the rate of working of the beds may be temporarily increased without subsequent ill effect.

It appears that the period of rest is of more consequence than the period of contact, and that in most cases it is not advantageous for the latter to exceed one hour.

Other things being equal it appears preferable to allow a bed a period of complete rest rather than simply to reduce the number of fillings as it has been found, after a rest say of a week, that nitrification continues exceptionally active for about ten days.

Appendix 9C.

COMPOSITION OF FILTRATE.

The filtrate obtained from bacteria beds dealing with septic tank effluent has been found to contain enough residual oxygen either in solution or in combination as nitrate to further oxidise any impurity still remaining or even to purify a certain proportion of less perfectly treated sewage. If abundance of air be also present this oxidation will be carried further.

GENERAL CONCLUSIONS.

The experiments have shown that by means of a septic tank and one contact bed, non-putrefactive filtrates may almost invariably be obtained; by providing one secondary bed to two primary beds a filtrate of exceptional purity may be obtained.

With careful working it appears possible to deal with the septic tank effluent on primary beds at the rate of 750,000 gallons per day; allowing, therefore, one secondary bed to two primary beds, a total area of 60 acres should be adequate to deal with an average flow of 30,000,000 gallons per day.

MAINTENANCE OF BEDS. RESTING PERIODS.

The choice of lengthened periods of rest will be conditioned by (i.) the state of the bed, (ii.) the weather, and (iii.) the season of the year, *e.g.*—

(i.) If a bed is working well, and its capacity appears to be maintaining itself, it would not be economical to interrupt its activity.

(ii.) If possible, necessary rests should be given when the weather is fine, dry and breezy.

(iii.) It will not be advisable to rest the beds for a lengthened period in very cold weather, as in the absence of the heat of the sewage, the bacterial activity is to a large extent inhibited. If it is necessary to rest under these conditions it should be done by reducing the number of fillings per day.

Judgment will be required to be exercised in all cases in considering the simultaneous effect of variations in the above conditions.

WORK UPON THE SURFACE OF THE BEDS.

At no time should the surface of a bed be allowed to become water-logged. If such a tendency manifests itself the bed should be rested, and the surface raked to not more than the depth of the upper layer. If raking is not adequate for the purpose it may be necessary to remove some of the top layer and pile it in heaps, possibly on the bed itself, for an indefinite length of time, to recover. This may be eventually put back in place of further clogged material.

QUESTION 22

(a). It has been concluded that a system of open septic tanks and contact beds may safely be recommended for the purification of the sewage of Manchester.

The capital cost, in addition to the cost of the present works, has been estimated at £347,700, or 12s. 8d. per head of population. This includes an area of 46 acres of primary beds at Davyhulme, connected by a conduit to 23 acres of secondary beds at Carrington, together with roadways, electrical equipment for working the sluices and lighting the works.

The estimate also includes provision of 25 acres of storm beds and a liberal allowance for sundries and contingencies.

The cost of present works, excluding purchase and under-drainage of land, is £165,500, or 6s. per head of population. It may be taken, therefore, that for a population of 550,000 the bacterial system may be applied at a total capital cost per head of 18s. 8d.

(b). This has been estimated at £20,000, or 9d. per head of population.

The estimate includes cost of working and maintaining the beds (raking, renewing surface, and washing once in 10 years), the disposal of residual sludge and general expenses of management.

GILBERT J. FOWLER,

March 6th, 1901

Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS. (SINGLE CONTACT.)

Name of authority - - - - - -	County Borough of St. Helens.
Population of district, estimated to June, 1901 - -	90,444.
Water supply per head of the population - -	Domestic supply 21 gallons per day. Domestic, including trade, 39 gallons per day.
Measured dry weather flow of sewage - -	2,000,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	No, but there is drainage from chemical waste heaps after rain. Impossible to state proportion affected.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially excluded.
Officers under whom the experiment has been conducted	The Borough Engineer and the Medical Officer of Health.
Name and qualification of chemist who has made the analyses.	F. Drew Harris, M.B., London, M.R.C.S., D.P.H., Medical Officer of Health and Public Analyst for Borough.

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	56,000 gallons.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	One only.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge? If the sludge was removed from the septic tanks, state how often this was done, and, approximately, what quantity of sludge was removed on each occasion.	Yes. Little or no sludge appears to be in the tank. It has not yet been emptied, having only been working four months.
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	Not ascertained. We have only two beds, each filled with similar filtering material.
(*b*) What was the depth of these beds?	3 ft.
(*c*) What were the nature and size of the filtering material?	2 ft. 10 in. coarse clinker held up by $\frac{1}{2}$ in. and 2 in. of siftings.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	Not ascertained.
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	Experiments are still going on.
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	We have no fine beds.
(*b*) What was the depth of these beds? - - -	
(*c*) What were the nature and size of the filtering material?	
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?	
(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	First bed filled 8 a.m.; stands full one hour; effluent distributed to second bed 9 a.m.; stands full one hour; each bed rests seven hours. Second filling takes place 4 p.m.; stands one hour; effluent distributed to second bed at 5 p.m.; stands one hour; beds rest till following morning at 8.

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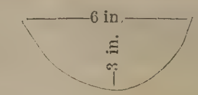
(10) State by what method the tank liquor was distributed on the beds.

By means of 6 in. half-pipe channel laid across bed-



(11) What was the average quantity of sewage in gallons dealt with daily?

About 1,600 gallons each filling.

(12) Was the quantity of sewage dealt with increased in time of storm?

If so, state to what extent, and how the results were affected by such increase.

No.

(13) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to settle before being analysed.

Effluent analysed twice daily, *i.e.*, from each filling.

Not filtered through paper or allowed to settle before analysis.

(14) Give (*a*) the average of the analyses of the final effluent from the beds;

Ammoniacal nitrogen, 0·62 per 100,000.

Albuminoid nitrogen, 0·10 per 100,000.

(*b*) the best analysis of the final effluent and date when sample was taken; and

5th January, 1901—Albuminoid nitrogen = 0·04 per 100,000.

(*c*) the worst analysis of the final effluent, and date when sample was taken;

6th November, 1900—Albuminoid nitrogen = ·22 per 100,000.

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed;

None made.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

None made. Effluent not putrescible.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

Parts per 100,000:

Total solids	437·6
Ammoniacal nitrogen	2·3
Albuminoid nitrogen	0·9
Nitric nitrogen	0·0
Chlorine	148·3
Suspended matter	51·4

(16) Between what dates was the experiment conducted?

If there were any periods of rest, state their duration.

Commenced 3rd November, 1900, and is still proceeding.

(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.

None made.

(18) Was any nuisance caused by the experimental works?

No.

(19) Is the experiment still proceeding? - - - -

Yes.

If so, may the Commission inspect the works, should they deem it desirable to do so?

There is but little to see, but of course that little may be seen if desired.

(20) Give particulars of any other observations of importance which were recorded.

There is a marked improvement in the effluent from the final bed as compared with that from the first bed. This is evidenced by the great dimunition in the albuminoid nitrogen and the ammoniacal nitrogen found in the final effluent, and also by the presence in it of a quantity of nitric nitrogen which is entirely absent in the first.

(21) What inferences have been drawn from the experiment?

At present the purification is regarded as satisfactory, but further experience is necessary before making any inference.

(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

The point has not been considered.

(*a*) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.

(*b*) What would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

GEO. WM. BAILEY,
Town Clerk, St. Helens,

22nd February, 1901.

Signature of Officer of Committee under whose direction the experiment was conducted

Appendix

Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS (DOUBLE TANK.)

Name of authority - - - - - - - -	Walsall.
Population of district - - - - - - - -	2,200 drain to these outfall works.
Water supply per head of the population - - -	20 gallons per day.
Estimated or measured dry weather flow of sewage -	78,240 gallons per day.
Is any trade refuse taken into the sewers? - - -	Yes, two small breweries.
If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil, or surface water, wholly or partially, excluded from the ordinary sewers?	No. A quantity of storm and subsoil water finds its way into sewers, probably nearly 50 per cent.
Officer under whom the experiment has been conducted -	Borough Surveyor.
Name and qualification of chemist who has made the analyses.	F. E. Thompson, A.R.C.S.Lond., F.C.S.

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	23,000 gallons.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	One.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge? If the sludge was removed from the septic tanks, state how often this was done, and, approximately, what quantity of sludge was removed on each occasion.	No sludge has been removed up to the present. N.B.—Previously this tank was used as a settling tank, and was always full in three months, but since being turned into a septic tank six months ago it has not been emptied, and soundings taken indicate the formation of practically no sludge.
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	5,000 gallons.
(*b*) What was the depth of these beds? - - -	2 ft. 6 in.
(*c*) What were the nature and size of the filtering material?	Blast furnace slag broken to a 2-in. size.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No accurate observation taken, but they have lost about one-third of original capacity. After six months continuous working one of the beds was cleaned out, and there was found only a slight black sediment formed alongside of some of the underdrains.
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and, if so, what was the duration of the resting?	No experiment.
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	Our fine beds each hold 5,000 gallons.
(*b*) What was the depth of these beds?	1 ft. 9 in. (material).
(*c*) What were the nature and size of the filtering material?	Blast-furnace slag passed through 1-in. and held on $\frac{1}{4}$-in. riddle.
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	No experiments concluded.
(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?	No experiments concluded.
(*b*) Was this measurement made after resting, and, if so, what was the duration of the resting?	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of 24 hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	We have only four top and four bottom beds laid experimentally, and obtain two fillings per 24 hours. The time taken in filling varies according to the flow of sewage; the sewage is held in contact in coarse beds for four hours, the beds empty in about $1\frac{1}{2}$ hours, and never rest less than two hours. It is quite impossible to work the beds to any fixed hours, as the flow varies so much.
(10) State by what method the tank liquor was distributed on the beds.	Runs into a chamber, and then fills up gradually is not spread on surface at all.
(11) What was the average quantity of sewage in gallons dealt with daily?	30,000.

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(12) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.

All above the 300,000 gallons is turned on to land. When storm water has been dealt with very good results have been obtained.

(13) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper, or allowed to settle before being analysed.

Not filtered or allowed to stand, but were agitated before being analysed.

(14) Give (a) the average of the analyses of the final effluent from the beds;

Total solids dried at 212° Fahr.	= 99·3	parts per 100,000.
Ammoniacal nitrogen	= ·37	" "
Albuminoid nitrogen	= ·14	" "
Nitric nitrogen	= ·06	" "
Combined chlorine	= 9·90	" "
Oxygen absorbed at 80° Fahr.	= ·52	" "

(b) the best analysis of the final effluent, and date when sample was taken; and

(c) the worst analysis of the final effluent, and date when sample was taken;

Total Solids.	Ammoniacal NH_3.	Albuminoid NH_3.	Nitric NH_3.	Chlorine.	Oxygen absorbed.
77·4	·16	·08	·06	6·7	·39
				(31st December, 1900.)	
97·5	·60	·33	None.	9 3	·83
				(8th October, 1900.)	

(d) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed;

We take total solids.

(e) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

See above reply.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

Total Solids.	Ammoniacal NH_3.	Albuminoid NH_3.	Nitric NH_3.	Chlorine.	Oxygen absorbed.
169·3	3·15	2·00	Trace.	9·0	7·44

(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.

(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.

None taken.

(18) Was any nuisance caused by the experimental works?

No.

(19) Is the experiment still proceeding?

Yes.

If so, may the Commission inspect the works should they deem it desirable to do so?

Yes.

(20) Give particulars of any other observations of importance which were recorded.

Occasionally the final effluent, on keeping for a few days, becomes of a brown colour, and a reddish brown deposit collects. A test is about to be made as to its composition.

Generally the effluents are found to improve on keeping.

Some nine months ago we started the bacteria beds with crude sewage, but they soon began to show signs of secondary decomposition through blocking.

About five weeks ago the beds were completely thrown out of condition owing to sufficient arsenical beer being run off (one night) to fill the whole of the beds once over with nothing but beer. They are now getting back after a rest.

(21) What inferences have been drawn from the experiment?

Our experience up to the present leads us to hope for satisfactory results.

(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state—

Question will be decided later on.

(a) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;

(b) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

R. H. MIDDLETON, A.M.I.C.E.,
Signature of Officer under whose direction the experiment was conducted.

Appendix 9C.

Form B.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK AND CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority	Corporation of York.
Population of district	About 75,000.
Water supply per head of the population	33 gallons per day.
Estimated or measured dry weather flow of sewage	45 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Trade refuse is so small as to be negligible.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Storm water above the capacity of the sewers, yes. Soil or surface, no.
Officer under whom the experiment has been conducted	City Engineer.
Name and qualification of chemist who has made the analyses.	(*a*) Thomas Fairley, F.I.C., F.R.S. Edinburgh, F.C.S. London, &c. (*b*) Edmund Moody Smith, M.D., C.M., Edinburgh, D.P.H. Cambridge, Medical Officer of Health, York.

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	250,000 gallons.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	One tank only.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	It is tested from time to time by a glass tube, but only a very slight deposit of about 2 inches has been found.
If the sludge was removed from the septic tanks, state how often this was done, and, approximately, what quantity of sludge was removed on each occasion.	The supernatant water was drawn off on 26th August, after 63 days use, when the sludge was found to average 2 inches over the whole area of tank; this was removed. No sludge has been removed since, and I cannot find more than 2 inches of sludge at date, though by the same means we can detect 6 inches of sludge in the adjoining tanks used for chemical precipitation.
(3) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	10,984.
(*b*) What was the depth of these beds?	3 feet 3 inches.
(*c*) What were the nature and size of the filtering material?	Clinker and coke, 3-8ths of an inch to 7-8ths of an inch.
(4) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	23rd November, 1900; 10,984, after $2\frac{1}{2}$ hours rest. 28th January, 1901; 8,648, after $2\frac{1}{2}$ hours rest.
(5) What was the water-holding capacity of the coarse beds at end of experiment? Was this measurement made after resting, and if so, what was the duration of the resting?	Experiment still in operation.
(6) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	Not ascertained; the surface of this bed has remained clear of any deposit throughout.
(*b*) What was the depth of these beds?	3 feet 3 inches.
(*c*) What were the nature and size of the filtering material?	All rejected by a $1\frac{1}{4}$-inch screen.
(7) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	Not ascertained. The second or fine bed might have been smaller as it has not filled more than 2 feet in depth, when contents of coarse filter has been run into it, and on no occasion has there been any deposit on the surface or has forking over been necessary.
(8) (*a*) What was the water-holding capacity of fine beds at end of experiment?	
(*b*) Was this measurement made after resting, and if so, what was the duration of the resting?	

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(9) State method of working of contact beds, *i.e.*, number of fillings per day of 24 hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying and (*e*) resting.	8 hour cycles. (*a*) $1\frac{1}{4}$ hours. (*b*) 2 hours. (*c* &) $4\frac{3}{4}$ hours.
(10) State by what method the tank liquor was distributed on the beds.	Semi-circular glazed drain pipes.
(11) What was the average quantity of sewage in gallons dealt with daily ?	From 30,000 to 32,000 gallons.
(12) Was the quantity of sewage dealt with increased in time of storm ?	No.
If so, state to what extent, and how the results were affected by such increase.	
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to settle before being analysed.	Weekly. Samples not filtered, but allowed to clear before being analysed.

(14) Give (*a*) the average of the analyses of the final effluent from the beds.

(*a*)	
Total solids	63·51
Mineral matter	60·51
Volatile and organic matter	3·0
Free ammonia	0·438
Albuminoid ammonia	0·124
Nitrogen as calcium nitrate	2·55
Nitrogen as nitrites	nil
Oxygen required to oxidise organic matter in four hours.	0·897
Reaction	Alkaline
Chlorine	6·76
Sediment	trace
Analysts	Mr. Fairley and Dr. Smith.

(*b*) the best analysis of the final effluent and date when sample was taken, and—

(*c*) the worst analysis of the final effluent and date when sample was taken.

(*b* & *c*)	Best. 9 Jan. 1901.	Worst. 29 Nov. 1900.
Total solids	63·51	—
Mineral matter	60·51	—
Volatile and organic matter	3·0	—
Free ammonia	·886	·4
Albuminoid ammonia	·0957	·28
Nitrogen as calcium nitrate	·743	5·0
Nitrogen as nitrites	trace	—
Oxygen required to oxidise organic matter in four hours.	·514	·93
Reaction	Alkaline	—
Smell (when cold)	slight earthy	
Chlorine	6·76	—
Sediment	trace	—
Containing organic matter	—	—
Analyst	Mr. Fairley and Dr. Smith.	

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the first bed.	Not ascertained.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible ?	Trace only, *i.e.*, under 1 grain. No.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

Total solids	96·43
Mineral matter	75·31
Volatile and organic matter	21·11
Free ammonia	4·0
Albuminoid ammonia	·943
Nitrogen as calcium nitrate	nil
Nitrogen as nitrites	nil
Oxygen required to oxidise organic matter in four hours.	3·43
Reaction	Alkaline
Smell (when cold)	very offensive
Chlorine	9·0
Sediment	28·84
Containing organic matter	25·28
Analyst	Mr. Fairley.

(16) Between what dates was the experiment conducted ? If there were any periods of rest, state their duration.	29th November, 1900, to date and containing only the periods in ordinary working.

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(17) Give particulars of any observations which have been made of the temperatures of the contact beds at different depths.

	Atmosphere.	No. 1 Bed.
29th November 1900 at 8 p.m.	42	47
1st December 1900 at 9 p.m.	42	47
3rd December 1900 at 9 a.m.	38	44
The lowest temperatures recorded from 29th November 1900 to 28th January 1901 were on 2nd January 1901 at 9 a.m.	28	40
2nd January 1901 at 9 p.m.	28	41
3rd January 1901 at 9 p.m.	28	41
9th January 1901 at 9.30 a.m.	23	40
16th January 1901 at 9 a.m.	27	41

We have daily temperatures of atmosphere in No. 1 Bacteria Bed from 19th December 1900 to date. These can be furnished if required; the above however are typical.

(18) Was any nuisance caused by the experimental works? — No.

(19) Is the experiment still proceeding? — Yes.

If so, may the Commission inspect the works, should they deem it desirable to do so? — Yes.

(20) Give particulars of any other observations of importance which were recorded. — This experiment has only been in operation since November.

(21) What inferences have been drawn from the experiment? — The experiment with open septic effluent has been too short a time in operation to enable me to express an opinion. The results however are satisfactory, so far as they go.

(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.

It is considered practicable to adopt this system, but in view of the superior results obtained by open septic tank treatment followed by continuous filtration (*see* Form G.) it is not considered expedient.

Note.—It is requested that all analyses may be given in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

This cannot now be done; the analyses are given as received. A standard form for sewage analyses is very much needed.

A. Creer.

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS (SINGLE CONTACT) AFTER CHEMICAL PRECIPITATION.

Name of authority	Batley Corporation.
Population of district	30,000.
Water supply per head of the population	For domestic purposes 12 gallons per day; for trade purposes 26 gallons per day.
Measured dry weather flow of sewage	500,020 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse	Yes, from wool washers, blanket makers, woollen manufacturers, dye works, carbonizers. About half the dry weather flow. *Note.* There are very few water closets in this Borough.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially.
Officer under whom the experiment has been conducted	Oscar J. Kirby.
Name and qualification of chemist who has made the analyses.	None made.
(1) What was the nature of the chemical or chemicals used?	Lime and alumino-ferrric.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	10 grains of lime; $3\frac{1}{2}$ grains of alumino-ferric.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	The lime was varied from 10 to 60 grains per gallon, and the alumino-ferric from $3\frac{1}{2}$ to 16 grains per gallon.
(4) What is the capacity in gallons of the subsidence tanks?	240,000.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	400 tons of creamy sludge once a week.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	From 1889 to 1893 intermittent. Since the latter date it has been continuous.
(7) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	It was not taken.
(*b*) What was the depth of these beds?	2 feet.
(*c*) What were the nature and size of the filtering material?	Coke, broken into 2-inch cubes.
(8) Give particulars of measurements made from time to time of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	None made. *Note.* This was not in any sense an ordinary experiment, *i.e.*, it was not done with the idea that we were experimenting, but that we were successfully treating the sewage first by precipitation and then by single contact in bacteria beds. We did not then know that the purification in the beds was bacterial, but we saw that the effluent was very much improved by being held up in the beds.
(9) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(10) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	
(*c*) What were the nature and size of the filtering material?	
(11) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(*b*) What was the water-holding capacity of fine beds at end of experiment? I the measurement was made after resting, please give the duration of the resting.	

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(12) State method of working of contact beds, *i.e.* number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Once a day in 1889, three times a day in 1892, five times a day in 1893, when it was decided to run it continuously.
(13) State by what method the settled sewage was distributed on the beds.	Through $4\frac{1}{2}$ in. by $4\frac{1}{2}$ in. apertures in a brick wall.
(14) What was the average quantity of sewage in gallons dealt with daily?	In 1889, 300,000 gallons, increasing daily to the present time, when it is 1,000,000 gallons.
(15) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No, the pumps always raised the same quantity.
(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	None taken.
(17) Give (*a*) the average of the analyses of the final effluent from the beds. (*b*) the best analysis of the final effluent and date when sample was taken, and (*c*) the worst analysis of the final effluent and date when sample was taken. (*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed. (*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	
(18) Give a typical analysis of the crude sewage to which the experiment relates.	
(19) Between what dates was the treatment conducted? If there were any periods of rest, state their duration.	This was ordinary work, not done in the sense of making an experiment.
(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	None made.
(21) Was any nuisance caused by the experimental works?	There was always a smell from the sludge lagoons.
(22) Is the treatment still proceeding? - - - - If so, may the Commission inspect the works, should they deem it desirable to do so?	No. But if the Commission did inspect they would see the contact beds which purified the sewage so well from 1889 till 1893.
(23) Give particulars of any other observations of importance which were recorded.	
(24) What inferences have been drawn from the treatment?	The following, viz.:— That in consequence of a great number of branch sewers being disconnected from natural streams and connected to the main intercepting sewers, the outfall works became too small to deal with the volume of sewage arriving there, with the result that the contact beds became continuous flow filters, which soon silt up and are as a consequence not nearly so economical for the treatment of Batley sewage as contact beds.
(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	It would be practicable, but it would be very costly.
(*a*) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	Ten shillings.
(*b*) What would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan	Two shillings.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note. 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

OSCAR J. KIRBY.

Signature of Officer under whose direction the treatment was conducted.

Appendix 9C. Form C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS (SINGLE CONTACT) AFTER CHEMICAL PRECIPITATION.

Name of authority	Calverley Urban District Council.
Population of district	3,000.
Water supply per head of the population	Ten gallons per day.
Estimated or measured dry weather flow of sewage	30,000 gallons per day.
Is any trade refuse taken into the sewers?	None whatever.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted	William Walker, Surveyor to the Council.
Name and qualification of chemist who has made the analyses.	No analyses have been taken on behalf of the Council. The West Riding Rivers Board occasionally take samples of effluent.
(1) What was the nature of the chemical or chemicals used?	Alumino-ferric.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	About 35 lbs. per day is used.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	No.
(4) What is the capacity in gallons of the subsidence tanks?	22,500 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	Tanks emptied of sludge at irregular periods, depends on rainfall and amount of road detritus carried down.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	There are no coarse beds.
(b) What was the depth of these beds?	
(c) What were the nature and size of the filtering material?	
(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	
(9) What was the water-holding capacity of the coarse beds at end of experiment?	
If the measurement was made after resting, please give the duration of the resting.	
(10) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	Was not ascertained.
(b) What was the depth of these beds?	Three feet.
(c) What were the nature and size of the filtering material?	Engine ashes through a ¼-in. mesh.
(11) (a) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	None taken.
(b) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	Not ascertained.
(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (a) filling, (b) standing full, (c) emptying, and (e) resting.	Once per day and resting one day.

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(13) State by what method the settled sewage was distributed on the beds.	By corrugated sheet iron plates.
(14) What was the average quantity of sewage in gallons dealt with daily?	30,000.
(15) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	Yes, to a certain extent, the storm overflow allowing more than the normal flow to go into and through the tanks and thus on to the beds. After a storm the surface of the beds are forked over to break up the skin of mud which is deposited on the surface.
(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	No analyses have been made on the Council's behalf.
(17) Give (*a*) the average of the analyses of the final effluent from the beds.	No observation.
(*b*) the best analysis of the final effluent and date when sample was taken, and	
(*c*) the worst analysis of the final effluent and date when sample was taken.	No observation.
(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.	No observation.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	No observation.
(18) Give a typical analysis of the crude sewage to which the experiment relates.	No observation.
(19) Between what dates was the experiment conducted?	The works here are put down as a permanency and have been working some time now.
If there were any periods of rest, state their duration.	No observation, except that there are three beds and they are rested in rotation.
(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	No observation.
(21) Was any nuisance caused by the experimental works?	None whatever.
(22) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(23) Give particulars of any other observations of importance which were recorded.	
(24) What inferences have been drawn from the experiment?	That the system adopted is suitable for domestic sewage from such a place as Calverley.
(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state.	
(*a*) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	
(*b*) What would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	Fourpence.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

William Walker.
Signature of Officer under whose direction the experiment was conducted.

Appendix C. Form C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS (SINGLE CONTACT) AFTER CHEMICAL PRECIPITATION.

Name of authority	Hendon Urban District Council.
Population of district	22,500. About 18,000 to 19,000 draining to the Outfall works at present.
Water supply per head of the population	About 35 gallons per day.
Measured dry weather flow of sewage	700,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Laundry work may be regarded as the staple industry of the place. This is also a residential suburb of London.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	In nearly all the roads there is a separate surface water drain as well as a sewer, and such surface water drain takes the water from the front roofs of most of the houses as well as all the water from the roads themselves.
Officer under whom the experiment has been conducted	Engineer and Surveyor.
Name and qualification of chemist who has made the analyses.	Mr. Frank Andrew, M.R.C.S., L.C.R.P., Medical Officer of Health, Hendon, N.W. Dr. Houston (crude sewage and resulting effluent from Col. Ducat's filter). Dr. Bevan, County Analyst.

(1) What was the nature of the chemical or chemicals used?	As to the proportion of the dry weather flow amounting to 450,000 gallons, *no* chemicals are now being used. As to 250,000 gallons forming the low-level flow 8 grains to a gallon of alumino-ferric or ferozone.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	Ditto.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	Yes. Same proportion as No. 1 up to one million gallons, then no extra chemicals used.
(4) What is the capacity in gallons of the subsidence tanks?	3 large tanks combined capacity - 471,718 3 small „ „ „ - 205,662 Total in Gallons 677,380
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	About 350 tons wet sludge. Each tank cleaned once a week.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous on six days. Quiescent one day for gauging (Wednesdays).
(7) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	120,000 gallons.
(*b*) What was the depth of these beds?	5 ft. average.
(*c*) What were the nature and size of the filtering material?	¾-in. clinker from breeze rejected by ⅛-in. sieve which removed the fine stuff.
(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	Each of the three coarse bacteria beds hold 120,000 gallons of effluent. Tank effluent first put through two acres of land, laid out for intermittent downward filtration and then allowed to fill bacteria beds.
(9) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	The coarse beds hold same now as when first started in September 1898, so far as can be gauged.
(10) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material? (*b*) What was the depth of these beds? (*c*) What were the nature and size of the filtering material?	No "fine" beds at present.
(11) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not. (*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	No "fine" beds at present.

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(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Each of the three coarse bacteria beds filled and emptied once a day. Resting empty on Sundays.
(13) State by what method the settled sewage was distributed on the beds.	Carriers and galvanized sluice plates to convey the filtrate from the two acres of land laid out for intermittent downward filtration.
(14) What was the average quantity of sewage in gallons dealt with daily?	120,000 gallons each of the three filters.
(15) Was the quantity of sewage dealt with increased in time of storm?	Yes.
If so, state to what extent, and how the results were affected by such increase.	With 1 in. rain in 24 hours, if during rainy time the dry weather flow is increased four times, *i.e.*:—to 2,000,000 gallons. A better effluent obtained with small quantity of rain, compared with effluent during dry summer.
(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Samples allowed to settle made from time to time—not at stated or regular intervals.
(17) Give (*a*) the average of the analyses of the final effluent from the beds.	Free ammonia - - - - 1·4 parts per 100,000 Alb. „ - - - - ·14 „ „ „ The amount of albuminoid ammonia in the crude sewage has been found by Dr. Houston as high as 7·6 per 100,000 and by Dr. Bevan 8·4 parts per 100,000. The albuminoid ammonia is never less than three parts per 100,000 on an ordinary day and in dry weather is much more frequently run up to eight parts per 100,000 and over.
(*b*) The best analysis of the final effluent and date when sample was taken, and	Alb. NH_3 ·13 per 100,000 on February 13th 1899.
(*c*) The worst analysis of the final effluent and date when sample was taken.	Alb. NH_3 ·17 per 100,000 on May 18th 1900.
(*d*) The average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.	Cannot give this. Dr. Barwise found in the crude sewage 315 parts of solid matter per 100,000, 198·5 parts of which were in suspension. Nov. 20, 1897. Free ammonia - 6·16 parts per 100,000. Organic „ - 3·8 „ „ „ Professor Corfield found on May 10th, 1898:— Total solids - - - - 265·3 parts per 100,000. Fixed - - - - 115·1 „ „ „ Volatile - - - - 150·2 „ „ „
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Dr. Bevan. Total solids dried at 212° Fahr. - 13·4 Solids in suspension - - - none Solids in solution - - - - 130·4 Mineral matters in solution - - 1·43 Alb. ammonia - - - - ·143 Oxygen consumed in three hours - ·51 Chlorine - - - - - 14·3 Dr. Bevan states that the percentage of purification is 93 per cent. on the albuminoid ammonia, and 82 per cent. on the oxygen.
(18) Give a typical analysis of the crude sewage to which the experiment relates.	*See* 14 (*d*) *ante*.
(19) Between what dates was the experiment conducted?	September 1898 and still going on.
If there were any periods of rest, state their duration.	Sundays, bacteria beds, always resting. Week days, each bed filled once a day.
(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	It has been noted that during the time sewage effluent was in contact with the filtering media in bacteria beds, temperature increased on an average 1° Fahr. only (thermometer placed two feet below the surface of bed).
(21) Was any nuisance caused by the experimental works?	There is none. (Far less than on the land.)

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(22) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	With pleasure any time.
(23) Give particulars of any other observations of importance which were recorded.	
(24) What inferences have been drawn from the experiment?	That it has been demonstrated beyond a doubt that open septic or detritus tanks, with a capacity of not less than one day's dry-weather flow, with subsequent filtration through land laid out on the intermittent downward filtration principle, and afterwards contact with bacteria, will produce an effluent which is not injurious to fish life, as the volume of the effluent is about ten times the volume of the flow in the River Brent, into which it discharges, as for many weeks in the year the volume of water flowing in the River Brent is under 22,000 gallons, gauged by S.S. Grimley. It will be noted that the sewage is particularly foul, being little more than a solution of soap on three days a week, in addition to the dense domestic sewage in all days. A better effluent can be obtained from artificial bacteria beds than from the clay land forming the site of the outfall works.
(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	Quite practicable.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;	10*s.* per head first cost of bacteria beds in addition to the present open septic or detritus tanks.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	2*l.* 10*s.* to 3*l.* per million gallons of dry weather flow. If all the water taken into account the mean would be 25*s.* to 30*s.* per million gallons treated. But it is far better to take the cost on the dry weather flow. Let this be understood to be uniform throughout the replies, *i.e.*, cost to be given on the dry-weather flow, which is the only reliable data.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

S. Slater Grimley,
Assoc.M.Inst.C.E.

Signature of Officer under whose direction the experiment was conducted.

Form C.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS (SINGLE CONTACT) AFTER CHEMICAL PRECIPITATION.

Name of authority - - - - - - - -	Heywood Corporation.
Population of district - - - - - - -	26,000.
Water supply per head of the population - - - -	20 gallons per day.
Estimated or measured dry weather flow of sewage -	800,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Partly from breweries and dye works. About 5 per cent
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted.	Sewage works manager.
Name and qualification of chemist who has made the analyses.	Joshua Bolton (advanced) S.K.
(1) What was the nature of the chemical or chemicals used?	Alumino-ferric.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	$8\frac{1}{2}$ grains.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	Varied according to strength.
(4) What is the capacity in gallons of the subsidence tanks?	675,000 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	380 tons per week (wet sludge).
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	No coarse beds.
(b) What was the depth of these beds?	Ditto.
(c) What were the nature and size of the filtering material?	Ditto.
(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No second contact beds.
(9) What was the water-holding capacity of the coarse beds at end of experiment?	Ditto.
If the measurement was made after resting, please give the duration of the resting.	
(10) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	About one-third.
(b) What was the depth of these beds?	4 feet 3 inches.
(c) What were the nature and size of the filtering material?	Sand and graduated coke.

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(11) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	No actual measurement taken until 3 months after commencement. Then 34 per cent. directly after emptying.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	34 per cent. No resting.
(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	3 fillings per day; 2 hours filling, 2 hours standing full, ½ hour emptying, 3½ hours resting.
(13) State by what method the settled sewage was distributed on the beds.	By open troughs.
(14) What was the average quantity of sewage in gallons dealt with daily?	200,000 (on the beds).
(15) Was the quantity of sewage dealt with increased in time of storm?	Slightly.
If so, state to what extent, and how the results were affected by such increase.	Good results.
(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Daily. Bottle shaken.
(17) Give (*a*) the average of the analyses of the final effluent from the beds;	(*a*) Oxygen absorbed 4 hours - - - - 1·2 Chlorine - - - - - - - - - 6·0 Free Ammonia - - - - - - - - 1·3 Abuminoid Ammonia - - - - - - - ·14 N as Nitrates - - - - - - - - 0·44 N as Nitrites not estimated.
(*b*) the best analysis of the final effluent and date when sample was taken and	(*b*) Oxygen absorbed 4 hours - - - - 0·4 Chlorine - - - - - - - - - 3·2 Free NH_3 - - - - - - - - ·16 Albuminoid Ammonia - - - - - - 0·18 Nitrates, traces, Oct. 31st 1900.
(*c*) the worst analysis of the final effluent and date when sample was taken;	Oxygen absorbed in 4 hours - - - - Chlorine - - - - - - - - - 9·1 Free Ammonia - - - - - - - - 1·1 Albuminoid Ammonia - - - - - - ·21 N as Nitrates, nil.
(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;	Not estimated.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Traces. Non-putrescible.
(18) Give a typical analysis of the crude sewage to which the experiment relates.	Average of many samples. Oxygen absorbed in 4 hours - - - - 7·7 Chlorine - - - - - - - - - 5·9 Free Ammonia - - - - - - - - 2·10 Albuminoid Ammonia - - - - - - ·51 Nitrates, nil.
(19) Between what dates was the experiment conducted?	Experiments continuous.
If there were any periods of rest, state their duration.	One day per week.
(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	Mean about 52° Fahr.
(21) Was any nuisance caused by the experimental works?	No.
(22) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(23) Give particulars of any other observations of importance which were recorded.	

The surface of the beds slowly became covered with a slimy deposit which obstructed the flow. This deposit was removed every 4 weeks. The beds have been at work over 3 years and are still working well.

(24) What inferences have been drawn from the experiment?	The works are most successful of their kind, embracing chemical precipitation and bacterial filtration.
(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(a) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	About 1*l*. 5*s*. per head.
(b) What would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	About 1*s*. 6*d*. per head, excluding interest on loans, &c.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

JOSHUA BOLTON.
Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS (SINGLE CONTACT) AFTER CHEMICAL PRECIPITATION.

Name of authority	Huddersfield Corporation.
Population of district	105,000.
Water supply per head of the population	Domestic purposes 14 gallons per day. Trade purposes 9 gallons per day.
Estimated or measured dry weather flow of sewage	Measured 7,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes, a large quantity, chiefly from the scouring, dyeing, and finishing of wool, &c.
If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	29 per cent. of dry weather flow.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	A large quantity of storm and surface water enters the sewers.
Officer under whom the experiment has been conducted	Borough engineer.
Name and qualification of chemist who has made the analyses.	Percy Coward.
(1) What was the nature of the chemical or chemicals used?	Lime and copperas.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	3·4 lime (CaO). 2·6 copperas.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	Sufficient chemicals were added to cause almost the whole of the matter in suspension to coagulate and settle in about 10 minutes. Generally during the early hours of the morning no chemicals would be needed. About noon as much as 12 grains of lime and 10 grains of copperas per gallon were required.
(4) What is the capacity in gallons of the subsidence tanks?	23 tanks, each 55,000 gallons capacity. Total capacity 1,265,000 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	892 cubic feet of liquid sludge per million gallons (about 90 per cent. water); or 3·9 tons of press cake per million gallons (about 54 per cent. water). 3 weeks.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	First contact beds (not coarse). No. 7, 19,230 gallons. No. 10, 19,940 gallons. No. 11, 17,660 gallons. No. 12, 19,200 gallons. *Note* 1.—No. 11 bed was constructed during wet weather. *Note* 2.—There are 24 beds for the single contact of the tank effluent. The above four are representative ones.
(b) What was the depth of these beds?	(b) 3 ft. 3 in.
(c) What were the nature and size of the filtering material?	(c) No. 7, destructor clinker, 6 in. rough, 2 ft. 9 in. of $\frac{3}{16}$ in. to 1 in. material. No. 10, ordinary clinker, 5 in. rough, 2 ft. of $\frac{1}{4}$ in. to $1\frac{1}{2}$ in., and 10 in. of $\frac{1}{4}$ in. to $\frac{3}{8}$ in. No. 11, ordinary clinker, 6 in. rough, 1 ft. 9 in. of $\frac{1}{2}$ in. to $1\frac{1}{2}$ in., and 1 ft. of $\frac{3}{16}$ in. to $\frac{1}{2}$ in.. No. 12, ordinary clinker, 6 in. rough, 2 ft. 9 in. of $\frac{3}{16}$ in. to 1 in.
(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	See table below.

No. 10 Bed.

Date.	Capacity (gallons).	Previous rest.
1898. 25th July	19,940	initial capacity.
29th July	17,030	3 hours.
6th September	15,580	3 "
11th October	15,160	3 "
1899. 27th February	13,400	2 "
3rd August	12,880	2 "
20th December	11,430	2 "
1900. 30th January	10,910	2 "
27th February	*12,150	2 "
18th June	11,110	2 "
13th August	10,590	2 "
24th September	10,180	2 "
26th November	9,760	2 "
1901. 14th January	9,040	2 "

* The fifth time of filling after resting three weeks.

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Question	Answer
(9) What was the water-holding capacity of the coarse beds at end of experiment?	See table below.
If the measurement was made after resting, please give the duration of the resting.	Each after two hours rest. *Note.*—These beds are still in operation.
(10) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	We have no large fine or secondary beds for the second contact of the tank effluent, but a small one has been constructed in the laboratory for giving the effluent from No. 10 bed a second contact.
(*b*) What was the depth of these beds?	This small secondary bed is 2 ft. 8 in. deep.
(*c*) What were the nature and size of the filtering material?	Furnace clinker ¼ in. to ¾ in., taken from No. 10 bed.
(11) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	None.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	3 fills per day. (*a*) 1½ hours. (*b*) 7½ „ (*c*) 1½ „ (*e*) 13½ „
(13) State by what method the settled sewage was distributed on the beds.	Trough.
(14) What was the average quantity of sewage in gallons dealt with daily?	5,500,000 gallons in tanks, of which 700,000 gallons receive one contact.
(15) Was the quantity of sewage dealt with increased in time of storm?	
If so, state to what extent, and how the results were affected by such increase.	No.
(16) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	The samples have been analysed daily. Neither filtered through paper, nor allowed to clear by standing.

Table to (9):

No.	——	——
7	13th August 1900 - - - - -	13,090
10	14th January 1901 - - - - -	9,040
11	„ „ - - - - -	8,720
12	„ „ - - - - -	8,620

(17) Give (*a*) the average of the analyses of the final effluent from the beds;

——	Date.	Albuminoid Nitrogen.	Oxygen absorbed in 4 hours at 80° F.
(*a*) Single contact - (No. 10 Bed effluent.)	July 1898 to March 1899.	·103	2·16
	March 1899 to March 1900.	·115	2·33
	June 1900 to January 1901.	·095	1·93
Double contact -	June 1900 to January 1901.	·059	1·11

(*b*) the best analysis of the final effluent and date when sample was taken; and

——	Date.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Oxygen absorbed. 3 min.	Oxygen absorbed. 4 hours.
(*b*) Single contact	16 Jan. 1899	·20	·023	·19	·59
Double contact	8 Aug. 1900	·01	·029	·20	·46

(*c*) the worst analysis of the final effluent and date when sample was taken;

——	Date.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Oxygen absorbed. 3 min.	Oxygen absorbed. 4 hours.
(*c*) Single contact	12 Sept. 1899	·73	·194	1·49	4·19
Double contact	12 Sept. 1900	·26	·108	·60	1·64

Question	Answer
(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;	Average of occasional analysis— Mineral, 1·54. Volatile, 4·69. Total, 6·23.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Only traces of suspended matter are present in the effluent. In no case has the effluent from double contact become putrescent when kept for seven days at 80° F. in a stoppered bottle (completely filled).

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(18) Give a typical analysis of the crude sewage to which the experiment relates.	Albuminoid nitrogen - - ·608 Total organic nitrogen - 1·23 Ammoniacal nitrogen - 1·24 Nitrous and nitric nitrogen ·02 Oxygen absorbed in 4 hours at 80° F.:— Sample shaken - - 9·71 Sample settled - - 7·69 Sample filtered - - 5·31 Chlorine - - - - 14·1 Reaction—Slightly alkaline to litmus. Solids. In suspension— Mineral - - 16·4 Volatile - - 18·2 Total - - 34·6 In solution— Mineral - - 59·7 Volatile - - 11·8 Total - - 71·5 Total solids— Mineral - - 76·1 Volatile - - 30·0 Total - - 106·1
(19) Between what dates was the experiment conducted?	Commenced July 1898, and still in progress.
If there were any periods of rest, state their duration	All the beds are rested on Sundays. The first contact bed, No. 10, had a rest of 10 days in August 1899, 21 days in February 1900. 12 days in November 1900.
(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	None made.
(21) Was any nuisance caused by the experimental works?	No.
(22) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(23) Give particulars of any other observations of importance which were recorded.	From experiments made, the following conclusions have been drawn:— 1st. That beds constructed of clinker obtained from the destructor on the works are as effective as those constructed of clinker or furnace ashes from the gas and various works in the neighbourhood. The destructor clinker is of a very different nature to the other clinker. 2nd. That beds constructed with the large and small pieces mixed, are slightly more effective than those in which the various sized pieces are separated or graduated. 3rd. That by lengthening the period of contact a slightly greater degree of purification only is effected. 4th. That the efficiency of the beds increases with the length of time they have been in operation.
(24) What inferences have been drawn from the experiment?	That it would be possible to satisfactorily purify the sewage of Huddersfield by chemical precipitation, settlement and contact beds. That there are periods of the day, and frequently during the whole day, when single contact would suffice for the purification of the tank effluent, and that at other times double contact would be necessary. The accumulation of irreducible matter in the beds is a serious item, but by freeing the tank effluent from as much suspended matter as possible, and by using only a very moderate quantity of lime this will be minimised. There is no doubt that portions of the beds will require taking out and washing or riddling from time to time.
(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	Yes.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;	£1 2*s*. 10*d*.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan?	10·3*d*.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:-

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

J. L. Campbell, M.Inst. C.E.,
Signature of Officer under whose direction the experiment was conducted.

Form C. Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS AFTER CHEMICAL PRECIPITATION.

Northern Outfall.—One-acre coke bed fed with screened and sedimented sewage.

Name of authority - - - - - - -	London County Council.
Population of district - - - - - - - (Sewage derived from London north of Thames.)	3,251,974 (1896).
Water supply per head of the population - - -	34·8 gallons per day (1900).
Estimated or measured dry weather flow of sewage -	123,000,000 gallons per day (1900).
Is any trade refuse taken into the sewers?	
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	All the trade refuse from the districts drained is taken into the sewers. The quantity is not known.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted	Professor Clowes, D.Sc.
Name and qualification of chemist who has made the analyses.	Mr. E. B. Pike.
(1) What was the nature of the chemical or chemicals used?	Lime and ferrous sulphate.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	5 grains of lime and 1 grain of ferrous sulphate per gallon of sewage. An invariable quantity of 780 cwt. of lime is used during the 24 hours. The proportion is, however, varied from hour to hour with average variation in the nature and volume of the sewage. The hourly quantity varies from 20 cwt. between 6 and 8 p.m. to 44 cwt. between 2 and 6 p.m.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	
(4) What is the capacity in gallons of the subsidence tanks?	About 20 million gallons, but only about 700,000 gallons per day are passed through the one-acre bacteria bed.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	From thirty to thirty-five thousand tons of sludge are produced per week. The tanks are cleaned about every 100 hours.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (a) What was the water-holding capacity at commencement of experiment of the bed when filled with the filtering material?	717,503 gallons or 41·9 per cent.—only one contact bed was used in these experiments. Its area was 5,067 square yards.
(b) What was the depth of these beds?	6 feet.
(c) What were the nature and size of the filtering material?	The lower 3 feet consisted of unsifted "pan breeze," the upper 3 feet of sifted coke fragments about the size of walnuts.
(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	Capacity in middle of May, 1898, 40·8 per cent. Early in July, 1898, 37·7 per cent. During this period the bed was filled once a day, and the capacity was taken after the bed had been draining from 20 to 22 hours. Capacity— 29 July, 1898 - 29·7 per cent - From July 4 the bed was filled twice a day. 8 Nov. - - 39·7 ,, ,, - The bed had been resting empty from July 29 to admit of structural alterations. 11 Mar., 1899 - 29·1 ,, ,, - Continues work from Nov. 8. 8 May, ,, - 38·4 ,, ,, - The bed had been resting empty from Nov. 11. 30 Dec. ,, - 2·66 ,, ,, - Continues working from May 8. The above five capacities were taken after the bed had been draining from 8 to 10 hours. The data of the capacity of this bed are not satisfactory or conclusive owing to the nature of the coke constituting the lower three feet of the bed.

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(9) What was the water-holding capacity of the coarse beds at end of experiment?

If the measurement was made after resting, please give the duration of the resting

(10) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

No fine beds were used.

(*b*) What was the depth of these beds?

(*c*) What were the nature and size of the filtering material?

(11) (*a*) Giving particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.

(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

One or two fillings per day.
(*a*) About 1 hour.
(*b*) 2 hours.
(*c* & *e*) 9 to 10 or 22 to 24 hours.

(13) State by what method the settled sewage was distributed on the beds.

Through wooden troughs with branches at intervals.

(14) What was the average quantity of sewage in gallons dealt with daily?

From 350,000 to 1,100,000 gallons.

(15) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Daily averages were analysed and the samples were filtered through paper previous to analysis except in the case of the estimations of total putrescible matter

(17) Give (*a*) the average of the analyses of the final effluent from the beds.

Averages for 1900:—

Oxygen absorbed from permanganate in four hours at 80° F.:	
By the total putrescible matter. - -	0·998
By the dissolved putrescible matter. -	0·835
Nitrous nitrogen - - - - - -	0·0539
Nitric nitrogen - - - - - -	1·0391

(*b*) the best analysis of the final effluent and date when sample was taken, and

28th October, 1901.

(*c*) the worst analysis of the final effluent and date when sample was taken.

29th May, 1901.

—	(*b*)	(*c*)
Oxygen absorbed from permanganate in four hours at 80° F.:		
By the total putrescible matter.	0·396	1·690
By the dissolved putrescible matter.	0·286	1·636
Nitrous nitrogen - - -	0·0300	0·0800
Nitric nitrogen - - -	1·1297	1·6368

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.

13 parts per 100,000.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Not estimated. None putrescible.

(18) Give a typical analysis of the crude sewage to which the experiment relates.

Average for 1900:—

Oxygen absorbed from permanganate in four hours at 80° F.:	
By the total putrescible matter. - -	11·546
By the dissolved putrescible matter. -	5·543
Solids in suspension - - - - - -	52·0
Solids in solution - - - - - -	98·0

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(19) Between what dates was the experiment conducted?	12th May, 1898, to date.
If there were any periods of rest, state their duration.	Every Sunday. 18 days extra during 1900. 6 days extra during 1901.
(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	None made.
(21) Was any nuisance caused by the experimental works?	No.
(22) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(23) Give particulars of any other observations of importance which were recorded.	During the last few years, since the extra 3 feet of coke were placed upon the original lower 3 feet, the lower layer has become compacted together and does not become drained from liquid when the bed is emptied. Hence the available capacity of the bed for working purposes is practically the upper 3 feet only. This seems to have been due to the use of unsifted coke for the lower part. It does not appear to affect in any way the quality of the effluent.
(24) What inferences have been drawn from the experiment?	That the coke bed when fed intermittently with sewage which has been roughly screened, then mixed with chemicals and subjected to sedimentation, effects a satisfactory purification, and that the effect is produced through an unlimited period of time without any loss of capacity of the bed, but that the coke used should be sifted and be of hard and suitable quality.
(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note 1.—It is requested that all analysis may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen;

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no "Septic" action is produced.

FRANK CLOWES,
Chief Chemist to the London County Council.
Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS AFTER CHEMICAL PRECIPITATION.

(Coke and Cinder Beds (Roscoe's.)

Name of authority	Manchester.
Population of district	400,000 in 1896 to 550,000 in 1900.
Water supply per head of the population	28 gallons per day, Domestic use, 17; trade purposes, 11. (1900.)
Estimated or measured dry weather flow of sewage	15,000,000 (estimated) in 1896 to 27,000,000 in 1900 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Breweries, dye and bleach works, galvanising works, grease refineries, tanneries, manufactories of tar products, rubber goods works, tripe-dressing works, and mineral water manufactories. 4 to 5 per cent.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enter the sewers. Storm-overflows are provided at certain points, which are supposed to come into action at a dilution of 5 to 1. In certain cases, however, they fail to answer their purpose.
Officer under whom the experiment has been conducted	Sir Henry Roscoe, F.R.S. F. Scudder F.I.C. Gilbert J. Fowler, M.Sc. (Vict.I.). F.I.C. (Supt.)
Name and qualification of chemist who has made the analyses.	W. Clifford, A.R.C.Sc.I. Edward Ardern, B.Sc. (Vict.). H. D. Bell, A. C. Oddie, E. Hadfield, } Junior Assistants. Under the direction of G. J. Fowler (Supt.)

(1) What was the nature of the chemical or chemicals used?

Date.	Cal.	Copperas.	Ferric Sulphate.	Alumina Ferric.
1896	6·28	6·04		Small amount occasionally used
1897	5·32	5·29		
1898	4·85	5·34	Used for short time	
1899	2·68	2·24		

The above numbers are calculated on the average flow including storm water.

(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?

Addition of chemicals suspended altogether in case of heavy storm, and latterly, often in the early hours of the morning when the sewage is dilute.

The addition of chemicals is regulated at other times by (1) the character of the precipitate produced in a test glass, and (2) reaction with phenol phthalein.

(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations

The amount of lime has to be increased considerably during the presence of acid waste or iron pickle, as much as 24 *grains Cal. per gallon* being added. The amount of both lime and copperas have to be increased in presence of dye-waste, as much as 29 *grains Cal. and* 12 *grains copperas* per gallon being added.

(4) What is the capacity in gallons of the subsidence tanks.

11 tanks.
Total capacity, 12,375,000 gallons.

(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.

From 3,000 to 4,000 tons (90 per cent.).
About once a week.

(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.

Continuous.

(7) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?

(*b*) What was the depth of these beds?

3 feet.

(*c*) What was the nature and size of the filtering material?

(1) coke. (2) clinker. Graded as follows, from the bottom upwards:—

12 inches rough.
9 „ sized to $1\frac{1}{2}$ in. mesh.
6 „ sized to $\frac{3}{4}$ in. mesh.
6 „ to pass $\frac{3}{8}$ in. and rejected by $\frac{1}{8}$ in.
3 „ washed gravel.

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(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.

(9) What was the water-holding capacity of the coarse beds at end of experiment?

If the measurement was made after resting, please give the duration of the resting.

(10) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

(b) What was the depth of these beds?

(c) What was the nature and size of the filtering material?

(11) (a) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

Date.	Coke (Capacity in Gallons.)	Cinder (Capacity in Gallons.)	Remarks.
1895. Dec. 19th -	1,750	1,750	
1897. April 26th -	1,296	1,260	1 hours rest.
April 28th -	1,332	1,404	8 ,,
May 27th -	1,380	1,477	17 ,,
July 2nd -	1,446	1,548	15 ,,
July 2nd -	1,425	1,476	2 ,,
July 2nd -	1,404	1,476	2 ,,
1898. Jan. 5th -	1,260	1,350	After 2 hrs. rest.
Jan. 7th -	1,278	1,368	After 15 hrs. rest.
Jan. 24th -	1,368	—	Fortnight's rest, then once filled. and $1\frac{1}{2}$ hrs. rest.
June 17th -	1,188	1,332	$1\frac{1}{2}$ hours rest.
Nov. 25th -	1,224	1,368	After $1\frac{1}{2}$ hrs. rest.
1899. Jan. 7th -	1,188	1,296	After 1 hrs. rest.
Jan. 9th -	1,278	1,368	After 20 hrs. rest.
April 26th -	1,152	1,260	After $1\frac{1}{3}$ hrs. rest.
Oct. 6th -	1,296	1,224	After 3 hrs. rest.
1900. Jan. 2nd -	1,224	1,188	After 9 days rest.
Jan. 2nd -	1,152	1,116	After $2\frac{1}{2}$ hrs. rest.
April 24th -	1,188	1,224	After 20 dys rest.
April 26th -	1,044	1,044	After $2\frac{1}{3}$ hrs. rest.
June 28th -	972	1,008	After $2\frac{1}{2}$ hrs. rest.
Sept. 4th -	1,116	1,116	After 6 days rest.
Sept. 6th -	1,008	1,008	After $3\frac{1}{2}$ hrs. rest.
1901. Jan. 7th -	1,008	1,089	After 36 hrs. rest.

(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

Method of working Coke and Cinder Beds:

Date.	No. of fillings per day.	Time of filling.
Dec. 19th, 1895 to Jan. 5th, 1896	1	
Jan. 6th to Jan. 21st, 1896 - -	2	
Jan. 22nd, 1896 to Jan. 1897	3	At 8 a.m., 12 noon, and 4 p.m.
Jan. to Mar. 8th, 1897 - -	3	,, 8 a.m., 12 noon, and 12 mdt.
Mar. 8th to April 21st, 1897 -	3	,, 8 a.m., 12 noon, and 4 p.m.
April 21st to May 5th, 1897 -	3	,, 8 a.m., 4 p.m., and 12 mdt.
May 12th to Dec. 15th, 1899 -	3	,, 8 a.m., 12 noon, and 4 p.m.
Dec. 16th, 1898 to May 31st, 1900	4	,, 8 a.m., 12 noon, 4 p.m., and 12 midnight.
*May 31st to present time - -	3	,, 8 a.m., 12 noon, and 4 p.m.

* During this period the beds have been worked on three fillings per day, with one week's rest for each working period of three weeks.

In general the cycle of operations in each case being:—

(*a*) $\frac{1}{2}$ hour.
(*b*) 2 hours.
(*c*) $\frac{1}{2}$ hour.
(*e*) Remainder of 24 hours according to the number of fillings.

The beds have always rested on Sundays.

(13) State by what method the settled sewage was distributed on the beds.

By means of iron channels, which pass up each side of the beds.

(14) What was the average quantity of sewage in gallons dealt with daily?

Coke 3,210 gallons per day, cinder 3,230 gallons per day.

(15) Was the quantity of sewage dealt with increased in time of storm?

If so, state to what extent, and how the results were affected by such increase.

No.

16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before analysed.

Daily except Sundays. Samples were shaken before analysis.

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(17) Give (*a*) the average of the analyses of the final effluent from the beds.

The following numbers are the average of daily analyses of the filtrates from the coke and cinder beds for the various periods given:—

Date.	Four Hours Oxygen Absorption.		Incubator Test. 3 minutes Oxygen Absorption. Before Incubation.		Incubator Test. 3 minutes Oxygen Absorption. After Incubation.		Putrescibility.		Ammoniacal Nitrogen.		Albumnioid Nitrogen.	
	Coke.	Cinder.	Coke.	Cinder.	Coke.	Cinder.	Coke.	Cinder.	Coke.	Cinder.	Coke.	Cinder.
Dec. 19, 1895, to Jan. 5, 1896 (1 filling per day.)	·94	1·19	—	—	—	—	—	—	2·16	1·94	·142	·136
Jan. 6—Jan. 21st, 1896 (2 fillings per day.)	1·30	1·28	—	—	—	—	—	—	2·01	2·09	·117	·105
Jan., 1896, to Dec., 1898 (3 fillings per day.)	1·73	1·39	·97	·74	·88	·61	31½/296	† 4½/310	1·93	1·63	·148	·128
Jan., 1899, to May 31, 1900 (4 fillings per day.)	3·41	2·61	2·04	1·51	2·44	1·53	65/106	28/112	1·70	1·50	·140	·120
May 31—Dec. 26, 1900* (3 fillings per day. Alternate periods of 3 weeks' work and 1 week's rest.)	2·91	2·27	1·63	1·16	1·83	1·04	54/120	19½/126	1·71	1·34	·140	·140

† The figures for 3 minutes' Oxygen Absorption refer to the average of daily analyses from April 21st, 1896, to December, 1898. The putrescibility numbers, to samples analysed from January to December, 1898, only.

The figures for 4 hours' oxygen absorption, ammoniacal and albuminoid nitrogen, refer to the average of daily analyses from May 31st to July 11th, 1900.

(*b*) The best analysis of the final effluent and date when sample was taken, and

(*c*) The worst analysis of the final effluent and date when sample was taken.

(*d*) The average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.

About 5·5 parts per 100,000.

(*e*) The average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Practically nil.

(18) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily samples of sewage for the periods given. The numbers for periods Sept. to Dec. 1897, and June to Dec. 1900 refer to crude sewage, the numbers for the other periods to settled sewage.

Period.	Four Hours. Oxygen Absorbed.	Three Minutes Oxygen Absorbed.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Chlorine.
Year 1896 (Settled Sewage)	3·86		2·50	0·447	
Jan.—Sept. 1897 (Settled Sewage)	6·18	2·78	2·43	0·39	15·0
Sept.—Dec. 1897 (Crude Sewage)	10·86	4·94	2·49	0·66	15·4
Year 1898 (Settled Sewage)	7·36	3·75	2·27	0·37	16·2
Year 1899 (Settled Sewage)	6·75	3·62	2·30	0·33	16·0
Jan.—June 27, 1900 (Settled Sewage)	7·86	3·93	1·91	0·335	16·3
June 27—Dec. 1900 (Crude Sewage)	11·11	5·49	2·23	0·59	17·0

(19) Between what dates was the experiment conducted?

If there were any periods of rest, state their duration.

From December 1895 until the present time, exclusive of Sundays, the total amount of rest in five year amounted to the following:

Coke, 33 weeks. Cinder, 29 weeks.

(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

(21) Was any nuisance caused by the experimental works?

No.

(22) Is the experiment still proceeding?

Yes.

If so, may the Commission inspect the works, should they deem it desirable to do so?

Yes.

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23) Give particulars of any other observations of importance which were recorded.

Maintenance of Beds.—During the first few years the surface of these beds required attention only very occasionally, and on the average not more than eight operations per annum were needed, in many of these cases a slight raking being all that was required. Frequently, however, the beds have been loosened with a fork to a depth of one foot.

Throughout the five years no material has been renewed; it has been found, however, that in process of time the surface of the beds has risen considerably above its original level, and this accumulated material has been on two occasions taken off and piled up in heaps on the bed. After the first of these occasions, when the piled material was sufficiently recovered, it was put back in the place of clogged portions of the surface which had been in their turn removed and piled. Recently, by way of experiment, the top foot or so of the material of the beds has been taken out, washed, re-screened and put back; a considerable increase in capacity resulted, though the level of the surface was several inches lower than previously. The washed-out portions rapidly dry to a perfectly inoffensive earthy residue; in the case of the cinder bed a considerable amount of broken-down clinker was present in the washed-out material. Two kinds of washed-out material were distinguished, a heavy and light, the former being easily spadeable, the latter forming a thin slurry which could be readily drained to a jelly-like mud when run on to the surface of an adjacent bed. The cost of this operation, on the small scale, averaged about 1s. 6d. per square yard. During the last year's working the surface of the beds, especially in wet weather, tended to become waterlogged; in such cases, instead of filling the bed with tank-effluent and allowing the ordinary time of contact, the liquid was allowed to percolate slowly through, the exit valve being kept open. The quantity thus dealt with was equal to one filling, and the purification was not seriously inferior.

(24) What inferences have been drawn from the experiment?

Maintenance of Beds.—Experience has shown that it is not advisable to loosen the bed below the top few inches, lest the fine suspended matter, accumulated on the surface, penetrates into the body of the bed.

In order to keep the beds open it appears well to take only the top few inches, and from time to time to turn the surface over to this depth.

From time to time it will probably be necessary to remove the top surface to a depth of a few inches and pile the material in heaps on the bed to recover, its place being taken by material already similarly treated.

It does not appear economical to wash this upper layer, but it should not be difficult to devise a method by which the looser material beneath should be washed at a reasonable cost, from time to time.

Purity of Effluent.—In judging of the results given, it should be borne in mind that in many cases where a sample has been returned as putrefactive, it is very much less so than the original tank-effluent, and in all probability a brief exposure to air would be all that is necessary to render it non-putrefactive.

(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

Cost of 50 acres of filters	£150,737
Cost of 26 acres storm beds	40,505
Sundries	8,758
	£200,000

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;

Say 8s. per head.

Amount already spent - 8s. per head of population.

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.

(*b*) 1s. per head, made up as follows:—

Raking, &c. of surface of 50 acres	£500
Washing of top foot every 5 years at 1s. 6d. per sq. yd.	3,500
Attendance on sluices, &c.	1,000
Present cost of treatment	20,000
Annual cost	£25,000

Note 1. It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no "Septic" action is produced.

GILBERT J. FOWLER,
Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS AFTER CHEMICAL PRECIPITATION.

Peat filter.

Name of authority	Manchester.
Population of district	430,764.
Water supply per head of the population	gallons per day.
Estimated or measured dry weather flow of sewage	17,230,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enter the sewers. Storm-overflows are provided at various points, which are supposed to come into action at a dilution of 5 to 1; in certain cases, however, they fail to answer their purpose.
Officer under whom the experiment has been conducted.	Gilbert J. Fowler, M.Sc. (Vict.) F.I.C.
Name and qualification of chemist who has made the analyses.	H. D. Bell, junior assistant under G. J. Fowler.
(1) What was the nature of the chemical or chemicals used?	Lime and copperas.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	CaO. 5·32. $FeSo_4 7H_2O$ 5·29
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	
(4) What is the capacity in gallons of the subsidence tanks?	11 tanks. Total capacity 12,375,000 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	3,000 tons per week. About once a week.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (a) What was the water-holding capacity at commencement of experiment of the bed when filled with the filtering material?	Could not be determined.
(b) what was the depth of the bed?	3 feet 6 inches.
(c) what was the nature and size of the filtering material?	Peat, cut in blocks about a foot square, from Carrington.
(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	
(9) What was the water-holding capacity of the coarse beds at end of experiment?	
If the measurement was made after resting, please give the duration of the resting.	
(10) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(b) What was the depth of these beds?	
(c) What was the nature and size of the filtering material?	
(11) (a) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(b) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (a) filling, (b) standing full, (c) emptying, and (e) resting.	

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(13) State by what method the settled sewage was distributed on the beds.	By means of wooden shoots.
(14) What was the average quantity of sewage in gallons dealt with daily?	
(15) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	
(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	
(17) Give (*a*) the average of the analyses of the final effluent from the beds;	Four hours' oxygen absorption. 0·70 parts per 100,000.
(*b*) the best analysis of the final effluent and date when sample was taken; and	
(*c*) the worst analysis of the final effluent and date when sample was taken;	
(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;	About five to six parts per 100,000.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Nil.
(18) Give a typical analysis of the crude sewage to which the experiment relates.	
(19) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	A few days during March, 1897.
(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	
(21) Was any nuisance caused by the experimental works?	No.
(22) Is the experiment still proceeding? If so, may the Commission inspect the works, should they deem it desirable to do so?	No.
(23) Give particulars of any other observations of importance which were recorded.	On admitting the tank effluent, the surface of the peat was covered in a very few minutes, shewing that but little water could penetrate into the interior of the filter. In process of time the water gradually disappeared, the peat swelling like a sponge, causing the wooden carriers to bend. Although the valve at the exit was left open, no more than a slight trickle could at any time be obtained from it, showing that the water was held up in the pores of the filter. On testing with an iron rod, the peat was found to be quite soft throughout. After repeated trials the rate of filtration was not found to increase, and the experiment was then abandoned.
(24) What inferences have been drawn from the experiment?	That peat is a most unsuitable material for purifying effluent.
(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state (*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers? (*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan?	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or o "Septic" action is produced.

Gilbert J. Fowler,
Signature of Officer under whose direction the experiment was conducted.

Appendix 9C Form C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS AFTER CHEMICAL PRECIPITATION.

Coal Filter.

Name of authority - - - - - - - -	Manchester.
Population of district - - - - - - -	430,000 at commencement; increased to 550,000.
Water supply per head of the population- - - -	gallons per day.
Estimated or measured dry weather flow of sewage- -	17,230,000 gallons to 27,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enter the sewers. Storm overflows are provided at certain points, which are supposed to come into action at a dilution of 5 to 1, in certain cases, however, they fail to answer their purpose.
Officer under whom the experiment has been conducted.	Gilbert J. Fowler, M.Sc., F.I.C. (Superintendent). W. Clifford, A.R.C. Sc.I. Edward Ardern, B.Sc. (Vict.). H. D. Bell, A. C. Oddie, E. Hadfield } Junior Assistants.
Name and qualification of chemist who has made the analyses.	Under the direction of G. J. Fowler (Supt.).
(1) What was the nature of the chemical or chemicals used?	Chiefly lime and copperas.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	1897 CaO. 6·28 $FeSO_47H_2O$ 6·04 1898 do. 4·85 do. 5·34 1899 do. 2·68 do. 2·24 Above numbers calculated on the average daily flow.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	
(4) What is the capacity in gallons of the subsidence tanks?	Eleven tanks. Total capacity 12,375,000 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	3,000 to 4,000 tons per week. About once a week.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (a) What was the water-holding capacity at commencement of experiment of the bed when filled with the filtering material?	Not determined.
(b) What was the depth of these beds?	3 feet.
(c) What was the nature and size of the filtering material?	Coal. 6 inches of large lumps at the bottom, 2 feet 6 inches all sizes up to ½-inch. On August 11th, the material was taken out and the dust removed by washing.
(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of bed, stating in each case whether the measurement was made after resting or not.	(see table below)
(9) What was the water-holding capacity of the coarse beds at end of experiment?	
If the measurement was made after resting, please give the duration of the resting.	

Date.	Capacity in Gallons.	Remarks.
28th April 1897 -	828	
6th Oct. 1897 -	1,260	The dust was washed out of material on August 11th.
26th Jan. 1898 -	1,026	After 2½ hours rest.
20th June „	828	„ 13½ „
16th Oct. 1899 -	756	„ 23½ „

(10) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

(*b*) What was the depth of these beds?

(*c*) What was the nature and size of the filtering material?

(11) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.

(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

For the most part (except from July 28th to Nov. 24th, 1897, when it was worked as a continuous filter), up to the beginning of 1899, the bed was filled *3 times per day*, at 8 a.m., 12 noon,and 4 p.m.

From 1899 to the end of the experiment, the bed received, in general, *4 fillings per day*. During this latter period, 2 short flushes were frequently given instead of one ordinary filling.

(13) State by what method the settled sewage was distributed on the beds.

By means of wooden shoots. From February 24th-July 31st, 1897 = 1,900 gallons per day.

(14) What was the average quantity of sewage in gallons dealt with daily?

From November 14th, 1897, to January 27th, 1900 = 2,340 gallons per day.

(15) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Daily, except Sundays. Samples shaken before analysis.

(17) Give (*a*) the average of the analyses of the final effluent from the beds;

The following numbers are the average of daily analyses for the two working periods:—

i. February 24th to July 31st, 1897.
ii. November 14th, 1897 to January 27th, 1900.

Date.	Four hours' Oxygen Absorption	Incubator test, 3 mins. Oxygen Absorption.		Putres-cibility.	Ammo-niacal Nitrogen.	Albu-minoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
		Before	After.						
February 24th to July 31st, 1897	1·19	·43	·36	11½/105	1·68	·124			
November 14, 1897, to January, 1900	1·90	1·00	1·03	110/576	1·35	·119			

(*b*) the best analysis of the final effluent and date when sample was taken; and

(*c*) the worst analysis of the final effluent and date when sample was taken;

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;

About 5 to 6 parts per 100,000.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Slight amount.

(18) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily samples of *Settled Sewage* for the years 1897, 1898, and 1899:—

Year.	Four hours' Oxygen Absorption.	3 mins. Oxygen Absorption.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Chlorine.
*1897	6·18	2·78	2·43	·39	15·0
1898	7·36	3·75	2·27	·37	16·2
1899	6·75	3·62	2·30	·33	16·0

* The figures for 1897 refer to the average from January to September only.

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(19) Between what dates was the experiment conducted?	From February 24th to July 31st, 1897, and November 24th, 1897, to January 25th, 1900. Between these periods the bed was worked as a continuous filter.
If there were any periods of rest, state their duration.	
(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	On certain occasions, when the bed showed signs of clogging, the filtrate appeared quite warm to the hand, as was also the interior of the bed, showing that rapid changes, possibly to some extent putrefaction, were going on.
(21) Was any nuisance caused by the experimental works?	No, although the filtrate sometimes smelt slightly of sulphuretted hydrogen.
(22) Is the experiment still proceeding?	No.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(23) Give particulars of any other observations of importance which were recorded.	Towards the end of the experiment some difficulty was experienced in keeping the bed open, but the clogging did not extend below the upper foot.
(24) What inferences have been drawn from the experiment?	The good qualities of the filtrate obtained are attributed chiefly to the fine grade of the material, rather than to any specific action of the coal, though such an action, comparable for instance to the purifying effect of animal charcoal, is not regarded as impossible.
(25) If it is considered that it would e practicable to adopt this system for the disposa of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no "Septic" action is produced.

Gilbert J. Fowler,
Signature of Officer under whose direction the experiment was conducted.

Form B. Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS AFTER CHEMICAL PRECIPITATION.

Burnt Clay.

Name of authority - - - - - - -	Manchester.
Population of district - - - - - - -	500,000 at commencement to 550,000.
Water supply per head of the population - - -	gallons per day.
Estimated or measured dry weather flow of sewage -	19,500,000 (about) to 27,000,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse	Yes.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enter the sewers.
Officer under whom the experiment has been conducted	Gilbert J. Fowler, M.Sc., F.I.C. (Supt.)
Name and qualification of chemist who has made the analyses.	W. Clifford, A.R.C. Sc. I. Edward Ardern, B.Sc. (Vict.) H. D. Bell, A. C. Oddie, E. Hadfield, } Junior Assistants. Under the direction of G. J. Fowler (Supt.)

(1) What was the nature of the chemical or chemicals used? — Lime and copperas.

(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?

1897	CaO 5·32	$FeSO_4 7H_2O$	5·29
1898	CaO 4·85	do.	5·34
1899	CaO 2·68	do.	2·24

(above numbers calculated on the average flow including storm water).

(3) State whether the chemicals were increased or decreased according to the nature and and volume of the sewage treated, and give particulars of any such variations.

(4) What is the capacity in gallons of the subsidence tanks? — 11 tanks. Total capacity, 12,375,000 gallons.

(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed. — 3,000 to 4,000 tons per week. About once a week.

(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent. — Continuous.

(7) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?

(b) What was the depth of the bed? — 3 feet.

(c) What was the nature and size of the filtering material? — Burnt clay. 6 inches of coarse lumps at the bottom. 2 ft. 6 in., from ½ in. to 1 in.

(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.

Date.	Capacity in Galls.	Remarks.
Oct. 6th, 1897 ...	1,944	
Jan. 6th, 1898 ...	1,690	15 hours rest.
„ 7th, „ ...	1,680	„ „
June 20th, „ ...	1,674	1½ „
Oct. 11th, 1899 ...	1,260	1½ „
„ 16th, „ ...	1,656	Bed rested and forked over in meantime, 2½ hours rest.

(9) What was the water-holding capacity of the coarse beds at end of experiment?

If the measurement was made after resting, please give the duration of the resting.

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Question	Answer
(10) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	
(*c*) What was the nature and size of the filtering material?	
(11) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	See table below. During the latter period, one filling was omitted for a few weeks. In general, the cycle of operation was: (*a*) ½ hour, (*b*) 2 hours, (*c*) ½ hour, (*e*) remainder of day, according to the number of fillings.
(13) State by what method the settled sewage was distributed on the beds.	By means of wooden shoots, laid on the surface of the bed.
(14) What was the average quantity of sewage in gallons dealt with daily?	5,000 gallons per day, nearly.
(15) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No.
(16) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Daily except Sundays. Samples shaken before analysis.
(17) Give (*a*) the average of the analyses of the final effluent from the beds;	The following numbers are the average of daily analyses during the whole period of working, from November 17th, 1897, to March 14th, 1900:—

Date.	No. of Fillings per day.	Time of Filling.
Nov. 17, 1897, to Dec. 8th, 1898...	3	8 a.m., 12 noon, & 4 p.m.
Dec. 16th, 1898, to Mar. 14th, 1900	4	8 a.m., 12 noon, 4 & 9 p.m.

Four Hours' Oxygen Absorption.	Incubator Test, 3 mins'. Oxygen Absorption.		Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.
	Before.	After.			
2·93	1·53	1·64	385½/645	1·62	0·14

Question	Answer
(*b*) the best analysis of the final effluent and date when sample was taken; and	
(*c*) the worst analysis of the final effluent and date when sample was taken;	
(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;	About 5·5 parts per 100,000.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Varying appreciable amounts not determined.
(18) Give a typical analysis of the crude sewage to which the experiment relates.	The following numbers are the average of daily analyses of *Settled Sewage* for the years 1898 and 1899:—

Date.	Four Hours' Oxygen Absorption.	3 mins. Oxygen Absorption.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Chlorine.
Year 1898	7·36	3·75	2·27	0·37	16·2
1899	6·75	3·62	2·30	0·33	16·0

(19) Between what dates was the experiment conducted?	November 17th, 1897, to March 14th, 1900.
If there were any periods of rest, state their duration.	Every Sunday, and from July 23rd—August 11th, 1898. Total rest—140 days.
(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	
(21) Was any nuisance caused by the experimental works?	No.
(22) Is the experiment still proceeding?	No.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(23) Give particulars of any other observations of importance which were recorded.	The bed required comparatively little raking or attention, remaining open for some considerable period of time. A large proportion of the filtrates were putrefactive. The material on being piled in heaps and exposed to the weather, recovers itself to a large extent, and it could be very readily washed.
(24) What inferences have been drawn from the experiment?	Burnt clay, such as is produced at Davyhulme, appears to be too slaty in fracture to form a good filtering medium, but it could probably be used satisfactorily for constructing storm-beds.
(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "Septic" action is produced.

GILBERT J. FOWLER,
Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS AFTER CHEMICAL PRECIPITATION.

Red Sand Filter.

Name of authority	Manchester.
Population of district	430,764.
Water supply per head of the population	
Estimated or measured dry weather flow of sewage	17,230,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	New manufacturing district coupled up, just prior to this experiment.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enter the sewers.
Officer under whom the experiment has been conducted	Gilbert J. Fowler, M.Sc. (Vict.), F.I.C.
Name and qualification of chemist who has made the analyses.	H. D. Bell, junior assistant under G. J. Fowler.
(1) What was the nature of the chemical or chemicals used?	Lime and copperas.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	Cal. 5·32. $FeSO_47H_2O$ 5·29.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	
(4) What is the capacity in gallons of the subsidence tanks?	Eleven tanks. Total capacity, 12,375,000 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	3,000 tons a week. About once a week.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (a) What was the water-holding capacity at commencement of experiment of the bed when filled with the filtering material?	600 gallons.
(b) What was the depth of these beds?	3 feet.
(c) What was the nature and size of the filtering material?	6 inches of hard red sandstone rock at the bottom, 2 feet 6 inches of fine red sand.
(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	
(9) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(10) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(b) What was the depth of these beds?	
(c) What was the nature and size of the filtering material?	
(11) (a) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(b) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	

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(12) State method of working of contact bed, *i.e.*, the number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	First week - - - - - 2 fillings per day. Second week - - - - - 2 or 3 fillings per day. (*a*) $\frac{1}{2}$ hour. (*b*) 2 " (*c*) $\frac{1}{2}$ " (*e*) 18 "
(13) State by what method the settled sewage was distributed on the beds.	By means of wooden shoots laid on the surface of the bed.
(14) What was the average quantity of sewage in gallons dealt with daily?	1,500 gallons per day.
(15) Was the quantity of sewage dealt with increased in time of storm?	No.
If so, state to what extent, and how the results were affected by such increase.	
(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Daily except Sundays. Shaken.
(17) Give (*a*) the average of the analyses of the final effluent from the beds;	4 hours oxygen absorption - - 1·24 Ammoniacal nitrogen - - - ·86 Albuminoid nitrogen - - - ·09 All samples non-putrescent.
(*b*) the best analysis of the final effluent and date when sample was taken; and	
(*c*) the worst analysis of the final effluent and date when sample was taken;	
(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;	About 55 pints per 100,000
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Nil.
(18) Give a typical analysis of the crude sewage to which the experiment relates.	Average of analyses of *Settled Sewage* during time of experiment: 4 hours Oxygen absorption - - 9·13 Ammoniacal Nitrogen - - - 2·38 Albuminoid Nitrogen - - - ·42
(19) Between what dates was the experiment conducted?	May 20th to June 3rd, 1897.
If there were any periods of rest, state their duration.	Rested on Sundays.
(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	
(21) Was any nuisance caused by the experimental works?	No.
(22) Is the experiment still proceeding?	
If so, may the Commission inspect the works, should they deem it desirable to do so?	No
(23) Give particulars of any other observations of importance which were recorded.	The sand rapidly silted up, so that the experiment was abandoned at the end of a fortnight.
(24) What inferences have been drawn from the experiment?	That the sand used was unsuitable for filtering the tank effluent.
(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no "Septic" action is produced.

GILBERT J. FOWLER.
Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS AFTER CHEMICAL PRECIPITATION.

Rough Cinder Bed.

Name of authority	Manchester.
Population of district	550,000.
Water supply per head of the population	Domestic use, 17; trade purposes, 11. 28 gallons per day.
Estimated or measured dry weather flow of sewage	27,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Breweries, dye and bleach works, galvanising works, grease refineries, tanneries, manufactories of tar products, rubber goods works, tripe-dressing works, mineral water manufactories. 4 to 5 per cent.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enter the sewers. Storm-overflows are provided at certain points, which are supposed to come into action at a dilution of 5 to 1. In certain cases, however, they fail to answer their purpose.
Officer under whom the experiment has been conducted	Gilbert J. Fowler, M.Sc., F.I.C., Superintendent. W. Clifford, A.R.C.Sc.I. Edward Ardern, B.Sc. (Vict.) H. D. Bell, A. C. Oddie, E. Hadfield, } Junior Assistants.
Name and qualification of chemist who has made the analyses.	Under the direction of G. J. Fowler, Superintendent.

(1) What was the nature of the chemical or chemicals used?	Lime and copperas.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	CaO 2·68. $FeSO_4 7H_2O$ 2·24 (Calculated on the average flow, including storm water.)
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	Addition of chemicals suspended altogether in case of heavy storm and latterly often in the early hours of the morning when the sewage is dilute. The addition of chemicals is regulated at other times by (1) the character of the precipitate produced in a test-glass, and (2) the reaction with phenol phthalein. The amount of lime has to be increased considerably during the presence of acid waste or iron pickle, as much as *24 grains CaO* per gallon being added; the amounts of both lime and copperas have to be increased in presence of dye waste, as much as *29 grains CaO.* and *12 grains copperas* being added.
(4) What is the capacity in gallons of the subsidence tanks?	Eleven tanks. Total capacity, 12,375,000 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	3,000—4,000 tons per week. About once a week.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	
(*b*) What was the depth of this bed?	15 inches.
(*c*) What was the nature and size of the filtering material?	Unscreened clinker. All sizes up to 6 inches. Underdrains formed by grips cut into the surface of the land, filled with broken bricks.
(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	Exact measurements were not practicable, but the time occupied in filling has remained practically constant (with the same flow), during the last 12 months.
(9) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	

10) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

(b) What was the depth of these beds?

(c) What was the nature and size of the filtering material?

(11) (a) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (a) filling, (b) standing full, (c) emptying, and (e) resting.

Method of working coarse cinder bed.

Date.	No. of fillings per day.	Time of filling.
June 27th to Sept. 7th, 1899.	2	8 a.m. & 12 noon.
Sept. 7th, 1899 to Mar. 8th, 1900.	3	8 a.m., 12 noon & 4 p.m.
March 8th to May M30th, 1900.	4	8 a.m., 12 noon, 4 p.m., & 9 p.m.
ay 31st up to present time.	2 ordinary fillings No. of fillings increased in time of storm.	8 a.m. and 12 noon

In general the cycle of operations has been as follows:—(a) 20 minutes, (b) 2 hours, (c) ½ hour, and (e) remainder of 24 hours according to the number of fillings.

In the case of treatment of storm water, the time of contact is reduced to 1 hour.

The bed always rested on Sundays.

(13) State by what method the settled sewage was distributed on the beds.

By means of one large penstock, immediately beneath which a few sett stones were placed to receive the full force of the water, which then found its way over and into the bed without further direction.

(14) What was the average quantity of sewage in gallons dealt with daily?

33,500 gallons per day (including storm water).

(15) Was the quantity of sewage dealt with increased in time of storm?

Yes latterly, the increased amount dealt with varying with the dilution of the sewage, the number of contacts first being increased and finally the sewage is allowed to stream through the bed.

If so, state to what extent, and how the results were affected by such increase.

The maximum quantity of sewage thus dealt with being equal to 24 fillings per day.

In the majority of cases the filtrate was non-putrefactive, and the excessive rate of working does not cause any subsequent ill effects.

(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Daily except Sundays.

Samples shaken before analysis.

(17) Give (a) the average of the analyses of the final effluent from the beds;

The following numbers are the averages of daily analyses of (1) from June 27th, 1899, to May 30th, 1900, during which period the bed has been worked up from 2 to 4 fillings per day. (2) From June 13th to December 26th, 1900, during which period the bed has received 2 fillings per day in dry weather, the number of fillings being increased in time of storm.

Date.	Four Hours.	Incubator Test—3 min. Oxygen Absorption.		Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
		Before.	After.						
June 27th 1899 to May 30th, 1900	2·70	1·53	1·60	137½/277	1·38	·108	·028	·234	15·4
* June 13th, 1900, to Dec. 26th, 1900	2·41	1·36	1·11	10/119	1·14	·121	·043	·25	14

* Figures for this period for four hours oxygen absorption, nitrogen determinations and chlorine refer to the analysis of daily sample from May 31st to August 8th only. The figures for the incubator test are the average of daily analyses during the whole period.

(b) the best analysis of the final effluent and date when sample was taken; and

(c) the worst analysis of the final effluent and date when sample was taken;

(d) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;

About 5·5 parts per 100,000. In case of storm this amount is increased. In certain cases it was estimated at 17 parts per 100,000.

(e) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Small amount suspended matter. Actual amount not determined.

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(18) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily samples of *settled sewage* for the year 1899 and half-year ending June 27th, 1900, and of crude sewage for the half-year ending December 26th, 1900.

Date.	Four Hours Oxygen Absorption.	Three Minutes Oxygen Absorption.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Chlorine.
January to December, 1899. (Settled sewage.)	6·75	3·62	2·30	·33	16·0
January to June 27th, 1900. (Settled sewage.)	7·86	3·93	1·91	·335	16·3
June 27th to Dec. 26th, 1900. (Crude sewage.)	11·11	5·49	2·23	·590	17·0

(19) Between what dates was the experiment conducted? — From June 27th, 1899.

If there were any periods of rest, state their duration. — Every Sunday, and from May 30th to June 13th, 1900. Total rest = 80 days.

(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

(21) Was any nuisance caused by the experimental works? — No.

(22) Is the experiment still proceeding? — Yes.

If so, may the Commission inspect the works, should they deem it desirable to do so? — Yes.

(23) Give particulars of any other observations of importance which were recorded.

It was noted that although the filter had an earth bottom, and was surrounded on three sides by earth banks, very little leakage took place after the bed had been a short time in use. The tank effluent being admitted at one spot, such clogging as took place was immediately surrounding the inlet, the further portions of the filter still appear to be practically clean.

On exposing the soil bottom, a thin black film of iron sulphide was found to have formed, but this does not apparently tend to pollute the filtrate.

During the 18 months the bed has been at work, it has only been once necessary to run a light harrow over it.

It appears that beds for the purification of storm water, may be cheaply and effectively constructed after the model of the bed here described.

(24) What inferences have been drawn from the experiment

It is important only that the clinkers should be well burnt, and the fine portions sharp, so that they do not tend to set together. Such a bed should be capable of receiving one or two fillings a day of settled sewage, in fine weather, with a good result, and in time of storm the number of fillings may be increased to an almost unlimited extent in proportion to the dilution of the sewage.

(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers?

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan?

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no "Septic" action is produced.

GILBERT J. FOWLER,
Signature of Officer under whose direction the experiment was conducted.

Form C.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS AFTER CHEMICAL PRECIPITATION.

Carbonaceous Iron Sand Filter.

Name of Authority	Manchester.
Population of district	550,000.
Water supply per head of the population	Domestic use, 17 ; trade purposes, 11. 28 gallons per day.
Estimated or measured dry weather flow of sewage	27,000,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Yes.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enters the sewers. Storm overflows are provided at certain points, which are supposed to come into action at a dilution of 5 to 1. In certain cases, however, they fail to answer their purpose.
Officer under whom the experiment has been conducted.	Gilbert J. Fowler, M.Sc., F.I.C. (Supt.).
Name and qualification of chemist who has made the analyses.	Edward Ardern, B.Sc. (Vict.). H. D. Bell, A. C. Oddie, E. Hadfield } Junior Assistants. Under the direction of G. J. Fowler (Supt.).
(1) What was the nature of the chemical or chemicals used.	Line and copperas.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	CaO 2·5, $FeSO_4 7H_2O$ 2·0.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of such variations.	
(4) what is the capacity in gallons of the subsidence tanks?	Eleven tanks. Total capacity, 12,375,000 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	3,000 to 4,000 tons per per week. About once a week
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent	Continuous.
(7) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	
(*b*) What was the depth of this bed?	2 feet 6 inches.
(*c*) What was the nature and size of the filtering material?	Carbonaceous iron sand, consisting of fine screenings from iron waste heaps, composed chiefly of oxide of iron, silic and a small proportion of carbon. Six inches of rubble at the bottom, then 2 feet of fine carbonaceous iron sand.

(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.

Date.	Capacity in Gallons.	Remarks.
March 14th, 1900	1,000	3 hours draining
April 3rd	936	3¾ „ ,
June 29th	1,044	2½ „ „

(9) What was the water-holding capacity of the coarse beds at end of experiment?

If the measurement was made after resting, please give the duration of the resting.

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(10) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

(*b*) What was the depth of these beds? - - -

(*c*) What was the nature and size of the filtering material?

(11) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.

(12) State method of working of contact bed, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

1900. January 29th—March 14th, bed filled at 8 a.m. Cycle, (*a*) ½ hour; (*b*) 2 hours; (*c*) ½ hour; (*e*) 1 hour. Then 3 flushes of tank, effluent (exit valve open) between 12 noon and 4 p.m., 1 filling. Total quantity dealt with = 2 fillings per day.

March 15th—July 11th. As above, with additional filling at 9 p.m. Cycle, (*a*) ½ hour; (*b*) 2 hours; (*c*) ½ hour; (*e*) 8 hours. Total quantity dealt with = 3 fillings per day.

(13) State by what method the settled sewage was distributed on the bed.

By means of wooden shoots laid on the surface of the bed.

(14) What was the average quantity of sewage in gallons dealt with daily.

1,970 gallons per day.

(15) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Daily, except Sundays. Sample shaken before analysis.

(17) Give (*a*) the average of the analyses of the final effluent from the beds.

The following numbers are the average of daily analyses of the filtrate from the bed during the whole period of working:—

Four Hours Oxygen Absorption.	Incubator Test—3 mins. Oxygen Absorption. Before.	Incubator Test—3 mins. Oxygen Absorption. After.	Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitrico Nitrogen.	Chlorine.
	·61	·50	0/137	1·55	·061	·082	·61	15·6

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken.

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.

About 5 to 6 parts per 100,000.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Nil.

(18) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily analyses of *Settled Sewage* for the half-year ending June 27th, 1900:—

Four hours Oxygen Absorption.	Three minutes Oxygen Absorption.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Chlorine.
7·86	3·93	1·91	·335	16·3

(19) Between what dates was the experiment conducted?

January 29th to July 11th, 1900. Every Sunday, and from June 16th to June 28th.

If there were any periods of rest, state their duration.

Total rest—34 days.

(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

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(21) Was any nuisance caused by the experimental works.	No.
(22) Is the experiment still proceeding?	
If so, may the Commission inspect the works, should they deem it desirable to do so?	No.
(23) Give particulars of any other observations of importance which were recorded.	The sand was found to be very heavy and the surface tends to set, so that very frequent raking is necessary.
(24) What inferences have been drawn from the experiment?	Under the conditions of the experiment, the material appeared to receive too great an amount of suspended matter. Judging, however, from the excellent quality of the filtrate obtained, it seems likely that the material is capable of dealing with a liquid containing but little suspended impurity, *e.g.*, well clarified tank-effluent or filtrate from primary beds.
(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

Gilbert J. Fowler.
Signature of officer under whose direction the experiment was conducted.

Appendix 9C. Form C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS AFTER CHEMICAL PRECIPITATION.

CINDER SCREENINGS BED.

Name of Authority	Manchester.
Population of District	550,000.
Water Supply per head of the population	Domestic use - 17, Trade purposes, 11 } 28 gallons per day.
Estimated or measured dry weather flow of sewage	27,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Breweries, dye and bleach works, galvanising works, grease refineries, tanneries, manufactories of tar products, rubber goods works, tripe dressing works, mineral water manufactories.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	4 to 5 per cent. mostly enter the sewers. Storm overflow are provided at certain points which are supposed to come into action at a dilution of 5 to 1, in certain cases, however, they fail to answer their purpose.
Officer under whom the experiment has been conducted	Gilbert J. Fowler, M.Sc.; F.I.C. (Supt.) Edward Ardern, B.Sc. (Vict.) H. D. Bell, A. C. Oddie, E. Hadfield, } Junior assistants.
Name and qualification of chemist who has made the analyses.	Under the direction of G. J. Fowler (Supt.)

(1) What was the nature of the chemical or chemicals used?	Lime and copperas.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	CaO 2·5 $FeSO$ 4·7 H_2O 2·0
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	
(4) What is the capacity in gallons of the subsidence tanks?	Eleven tanks. Total capacity, 12,375,000.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	3,000 to 4,000 tons per week. About once a wee
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	
(b) What was the depth of these beds?	2 feet 6 inches.
(c) What was the nature and size of the filtering material?	Ordinary clinker screenings which have passed through a $\frac{1}{8}$-inch mesh; 6 inches at bottom of bed rough clinker, 2 feet screenings.
(8) Give particulars of measurements made from time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	(see table below)

Date.	Capacity in Gallons.	Remarks.
April 3rd, 1900	1,260	$2\frac{1}{2}$ hours draining.
June 29th, 1900	1,224	$2\frac{1}{2}$ ours draining.
January 7th, 1901	1,332	3 days' rest.

(9) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(10) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(b) What was the depth of these beds?	
(c) What was the nature and size of the filtering material?	

(11) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.

(12) State method of working of contact bed, *i.e.* number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

March 21st—April 12th, 1900.
1 filling (*a*) ½ hour, (*b*) 2 hours, (*c*) ½ hour, (*e*) 1½ hours.
Then 2 flushes of tank-effluent between 12 noon and 4 p.m. = to 1 filling.
Thus the amount dealt with = 2 *fillings per day*.
April 13th—December 26th, 1900.
As above, with an extra filling at 9 p.m., cycle (*a*) ½ hour, (*b*) 2 hours, (*c*) ½ hour, (*e*) 8 hours.
Total amount dealt with = 3 *fillings per day*.

13) State by what method the settled sewage was distributed on the beds.

By means of wooden shoots laid on the surface of the bed.

(14) What was the average quantity of sewage in gallons dealt with daily?

2,570 gallons per day.

(15) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Daily except Sundays. Samples shaken before analysis.

17) Give (*a*) the average of the analyses of the final effluent from the beds;

The following numbers are the average of daily analyses during the whole period from March 21st—December 26th.

Date.	Four Hours Oxygen Absorption.	Incubator Test 3 min. Oxygen Absorption.		Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine
		Before.	After.						
March 21st to Dec. 26th 1900.*	1·16	·57	·43	0/190	0·93	0·069			16·1

* The figures for 4 hours oxygen absorption, nitrogen determinations and chlorine represent the average of daily analyses from March 21st—August 1st. The incubator test figures are the average for the whole period.

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken;

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;

About 5 to 6 parts per 100,000.

e) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Nil.

( ) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily analyses of Crude Sewage for the half-year ending December 26th, 1900:—

Four Hours Oxygen Absorption.	3 minutes Oxygen Absorption.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Chlorine.
11·11	5·49	2·23	0·59	17·0

(19) Between what dates was the experiment conducted?

Commenced March 21st, 1900, still proceeding.

If there were any periods of rest, state their duration.

Total rest (including Sundays), 74 days.

(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

(21) Was any nuisance caused by the experimental works?

No.

(22) Is the experiment still proceeding?

Yes.

If so, may the Commission inspect the works, should they deem it desirable to do so?

Appendix 9C.

(23) Give particulars of any other observations of importance which were recorded.

It was found that in spite of its fine grade that the material remained open for a considerable time, raking being necessary about once a month.

The surface has been removed to the depth of about four inches and the material piled in heaps on the surface of the beds. On the second occasion the heaped material was put back in place of that which was removed. In this way it appears possible to prolong the life of a bed for a very considerable period. Recently the experiment has been tried of running the slurry obtained by washing the adjacent cinder filter on to the surface of the bed in question, in order to see if the mud would drain and be capable of removal from the surface of the bed, without injury to the medium. So far as this experiment goes it appears quite practicable to do this, and the experiment has its bearing on a choice of a method of washing the beds, should this at any time be necessary.

(24) What inferences have been drawn from the experiment?

The experiment indicates that the screenings from clinkers, which otherwise would be waste products, may be largely employed in covering the surface of contact beds, serving to arrest suspended matters, thus protecting the lower portions of the filter and forming an active nitrifying layer on the surface.

(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.

Note 1.—It is requested that all analyses may be stated in parts per 100,000 and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminiod nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

GILBERT J. FOWLER.

Signature of officer under whose direction the experiment was conducted.

Form C.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS AFTER CHEMICAL PRECIPITATION.

Spent Iron Ore Bed.

Name of Authority - - - - - - -	Manchester.
Population of District - - - - - - -	550,000.
Water Supply per head of the population - - -	Domestic use 17, Trade purposes 11 } 28 gallons per day.
Estimated or measured dry weather flow of sewage -	27,000,000 gallons per day.
Is any trade refuse taken into the sewers? - - -	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made of trade refuse.	
Is the storm, soil or surface water, wholly or partially. excluded from the ordinary sewers?	Mostly enter the sewer.
Officer under whom the experiment has been conducted	Gilbert J. Fowler, M. Sc., F.I.C. (Supt.) Edward Ardern, B.Sc. (Vict.) H. D. Bell, A. C. Oddie, E. Hadfield. } Junior Assistants.
Name and qualification of chemist who has made the analyses.	Under the direction of G. J. Fowler (Supt.)
(1) What was the nature of the chemical or chemicals used?	Lime and Copperas.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	Ca O 2·5. Fe. So_4 4·7 H_2O. 2·0.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	—
(4) What was the capacity in gallons of the subsidence tanks?	Eleven tanks. Total capacity 12,375,000 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	3,000 to 4,000 tons per week. About once a week.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	
(b) What was the depth of these beds?	3 feet.
(c) What was the nature and size of the filtering material?	Spent iron ore. 6in. large lumps at bottom, 2 feet coarse material (about 1in.) 6in. fine material which has passed through $\frac{1}{8}$in. mesh.
(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	see table below
(9) What was the water-holding capacity of the coarse beds at end of experiment?	
If the measurement was made after resting, please give the duration of the resting.	
(10) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(b) What was the depth of these beds?	
(c) What was the nature and size of the filtering material?	

Answer to (8):

Date.	Capacity in Gallons.	Remarks.
January 7th, 1901	1,548	2 days' rest.

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(11) (a) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

(b) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.

(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (a) filling, (b) standing full, (c) emptying and (e) resting.

Date.	No. of fillings per day.	Time of filling.
Aug. 25 to Jan. 17	2	8 a.m. to 12 noon.
1901	3	8 a.m., 12 & 9 p.m.

(a) ½, (b) 2 hours, (c) ½ hour, (e) remainder of time.

(13) State by what method the settled sewage was distributed on the beds.

By means of wooden shoots laid on the surface.

(14) What was the average quantity of sewage in gallons dealt with daily?

(15) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(16) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Daily except Sunday. Samples shaken before analysis.

(17) Give (a) the average of the analyses of the final effluent from the beds;

The following numbers are the average of daily analyses from Aug. 25—Dec. 26, 1900.

Oxygen Absorption. Four Hours.	Three Minutes. Oxygen Absorption. Before. Incubator.	After.	Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
2·31	1·59	1.43	6½/98	1·97	·109	·051	·030	16·4

(b) the best analysis of the final effluent and date when sample was taken, and

The figures for four hours' oxygen absorption, nitrogen determinations and chlorine refer to average from September 13th to October 10th, 1900.

(c) the worst analysis of the final effluent and date when sample was taken;

(d) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;

About 5 to 6 per 100,000.

(e) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Slight.

(18) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily analyses of Crude Sewage for the quarter ending December 26th, 1900.

Four hours Oxygen Absorption.	3 mins. Oxygen Absorption.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Chlorine.
11·46	5·47	2·01	0 61	16·6

(19) Between what dates was the experiment conducted?

Commenced August 28th, 1900—still proceeding.

If there were any periods of rest, state their duration.

Every Sunday and from December 6th to 13th. Filling occasionally missed at week ends.

(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

(21) Was any nuisance caused by the experimental works?

No.

(22) Is the experiment still proceeding?

Yes.

If so, may the Commission inspect the works, should they deem it desirable to do so?

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(23) Give particulars of any other observations of importance which were recorded.	Owing to the fineness of the material on the surface and its tendency to bind together, the bed soon became tight and took the water very slowly, thus requiring frequent attention. On December 17th, 1900, the top 3 inches were removed, after which the bed worked considerably better as regards clogging of surface.
(2) What inferences have been drawn from the experiment ?	The special character of the material apparently offered no particnlar advantage, as there was little nitrification and the samples were sometimes putrescent, even with only 2 fillings per day.
(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state (a) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers. (b) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen ;

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

GILBERT J. FOWLER.

Signature of officer under whose direction the experiment was conducted.

Appendix 9C.

Form C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS (SINGLE CONTACT) AFTER CHEMICAL PRECIPITATION.

Name of authority	Oldham Corporation.
Population of district	155,865.
Water supply per head of the population	22½ gallons per day.
Estimated or measured dry weather flow of sewage	4,000,000 gallons per day (estimated).
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Yes. Small quantities of tripe boiling refuse, brewing refuse, dye-water refuse, and foul water, from lodges of cotton mills; this latter is the worst we have to deal with, but the total quantity of trade refuse is a negligeable quantity.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially excluded. Over ¼-inch rainfall.
Officer under whom the experiment has been conducted	Dr. James B. Wilkinson, Medical Officer of Health.
Name and qualification of chemist who has made the analyses.	A. S. Wylie.
(1) What was the nature of the chemical or chemicals used?	Lime water and ferrous sulphate (green copperas).
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	Lime water, 4 grains per gallon. Ferrous sulphate, 1 grain per gallon.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	Yes, quantity increased or decreased according to volume of sewage by means of automatic machinery, designed by Mr. H. H. Law.
(4) What is the capacity in gallons of the subsidence tanks?	2,116,800 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	Unable to state the weekly quantity as each tank was working on an average 3 months before it was cleaned out, at the end of that time there was a depth of about 2 ft. 4 in. of sludge in each tank; about 10,500 cubic feet of wet sludge.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	Cubic capacity estimated at 40 per cent.
(*b*) What was the depth of these beds?	2 ft. to 2 ft. 9 in.
(*c*) What were the nature and size of the filtering material?	All the filters were made of furnace clinkers. All pieces which passed through a ¼-inch screen were rejected. Material was not graded in the filters.
(8) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No observations made
(9) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(10) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	
(*c*) What were the nature and size of the filtering material?	
(11) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(12) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Each bed was filled twice in 24 hours. (*a*) filling—½ to ¾ of an hour. (*b*) standing full—2 hours. (*c*) emptying—about 2 hours. (*e*) resting—interval between 1st and 2nd filling 2 hours at least.
(13) State by what method the settled sewage was distributed on the beds.	Distributed over beds by means of wooden carriers.

Appendix 9C.

(14) What was the average quantity of sewage in gallons dealt with daily?

484,000 gallons per acre.

(15) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(16) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Samples were taken daily, were analysed the day following. Samples were *not* filtered through filter paper, and were *not* allowed to clear by standing. Each sample was well shaken before being analysed.

(17) Give (*a*) the average of the analyses of the final effluent from the beds.

·91 of a grain of oxygen per 100,000 absorbed in 4 hrs. test.
1·9 " " " ammoniacal nitrogen.
·197 " " " albuminoid nitrogen.
8·57 " " " chlorine.

(*b*) the best analyses of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken.

June 22nd, 1898.

Oxygen absorbed 4 hours.	Ammoniacal nitrogen.	Albuminoid nitrogen.	Chlorine.
·21	1·01	·16	7·1
July 20th, 1898.			
3·44	5·34	·55	10·5

All estimated as parts per 100,000.

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.

None made.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Of 90 samples that were incubated 50 kept good, and 40 were putrescible. No estimations were made of solids in suspension in the final effluents.

(18) Give a typical analysis of the crude sewage to which the experiment relates.

Oxygen absorbed 4 hours.	Ammoniacal nitrogen.	Albuminoid nitrogen.	Chlorine.
4·53	4·0	1·1	13·4

parts per 100,000.

(19) Between what dates was the experiment conducted?

From beginning of 1897 to end of 1898.

If there were any periods of rest, state their duration

Yes. Filters rested every Sunday, and also periods of two to three weeks when necessary.

(20) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

None made.

(21) Was any nuisance caused by the experimental works?

No.

(22) Is the experiment still proceeding? - - - - -

No.

If so, may the Commission inspect the works, should they deem it desirable to do so?

(23) Give particulars of any other observations of importance which were recorded.

(24) What inferences have been drawn from the experiment?

The sewage of Oldham can be effectively purified without using chemicals as an aid to precipitation.
That the chemicals are an unnecessary expense, and, rather hinder the work of the bacteria beds than assist it. It is necessary, however, to add lime to the sludge to enable it to be pressed.

(25) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.

See answer to 24.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no "Septic" action is produced.

JAMES B. WILKINSON, M.D, C.M., D.P.H.
Signature of Officer under whose direction the experiment was conducted.
Medical Officer of Health.

Appendix 9C .Form D.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS.

Name of authority	Ashton-in-Makerfield U. D. Council.
Population of district	(Estimated) 20,000.
Water supply per head of the population	8 to 10 gallons per day.
Estimated dry weather flow of sewage	8 water supply. 2 other sources. 3 subsoil. — 13 to 15 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	No trade refuse dealt with in the districts under notic . Population, coal mining industry.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	In the districts dealt with storm water from roads and roofs partially is allowed in sewers. So subsoil water also gets in. In the district generally both storm, subsoil and surface water are carried by separate surface water drains.
Officer under whom the experiment has been conducted	John W. Liversedge, Surveyor.
Name and qualification of chemist who has made the analyses.	

(1) What is the capacity in gallons of the subsidence tanks?	Constructed July, 1900. 18ft. by 6ft. by 2ft. 6ins. deep. Capacity 1,600 gallons.
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	No actual measurements have been taken. The amount of dry sludge barrowed from the works since July, 1898, to the present, has been about 8 tons in addition to the sludge in the body of the beds.
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous flow.
(4) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	No actual measurement of such capacity was taken. I estimated the water capacity at half the cubic contents of the rough cinders, or total holding capacity level to bed of cinders, 31,500 gallons.
(b) What was the depth of these beds?	3ft. 6in. to 4ft. for first contact, or average depth, 3ft. 9in. Second contact—3ft. to 3ft. 6in., average, 3ft. 3in.
(c) What was the nature and size of the filtering material?	Hard cinder clinker from local collieries. First contact, all clinker retained on 1in. screen, large pieces broken to 3in. or 4in.
(5) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No experiments have taken place, but from personal observation reducing has taken place. In fact, I have during the past fortnight considered it advisable to have 8 ins. of cinders, the top layer, taken off and screened on 1-in. screen, the rough cinders put back, and the detritus removed. New cinders added to make up the depth. Owing to the surface water getting into the sewers quantities of road grit found its way into the beds, previous to putting down the subsidence tank, and at present the small tank down is not adequate to effect proper preliminary subsidence.
(6) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	No experiments.
(7) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	(Estimated) 26,000 gallons.
(b) What was the depth of these beds?	3 ft. to 3 ft. 6 in., average 3 ft. 3 in.
(c) What was the nature and size of the filtering material?	All cinders passed through the 1i-n. screen.

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(8) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	No experiments conducted.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	No direct experiment has been conducted, but from observation it would appear that the fine beds in the works under notice did not diminish in capacity as the rough beds referred to.
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Number offillings, 1, 2, or 3, depends on dry or wet weather flow. First Contact.—(*a*) filling, dry weather, 8 hours to 10 hours, (*b*) 2 hours to 4 hours, (*c*) 2 hours to 4 hours, (*e*) 8 or 12 hours, sometimes 16 hours; these times are halved or further reduced in periods of rain. Second Contact.—Effluent from first contact is spread over as great an area as possible, and percolates gently through the fine cinders; better results were perceived by this system than by closing the outlet valve and filling the bed full, with emptying and resting periods. The aeration of the bed seemed more complete.
(10) State by what method the settled sewage was distributed on the beds.	By means of half-pipes, stoneware, run diagonally and across the beds, and changed from time to time.
(11) What was the average quantity of sewage in gallons dealt with daily?	Dry weather 12,000 to 16,000 gallons, wet weather 25,000 to 50,000 gallons and over; the latter quantities imperfectly dealt with.
(12) Was the quantity of sewage dealt with increased in time of storm?	Yes.
If so, state to what extent, and how the results were affected by such increase.	The result of admitting storm water has the effect of chilling the beds and rendering less active the bacteria, and better results are noticed from crude sewage with high temperature than from diluted sewage by storm water. I do not think more than 3 or 4 times the dry weather flow should be put through crude sewage beds, but that land or separate storm beds would be advisable.
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	
(14) Give (*a*) the average of the analyses of the final effluent from the beds;	
(*b*) the best analysis of the final effluent and date when sample was taken; and	
(*c*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	
(15) Give a typical analysis of the crude sewage to which the experiment relates.	No analysis.
(16) Between what dates was the experiment conducted?	July, 1898, to the present time.
If there were any periods of rest, state their duration.	Short periods of rest in summer; each bed about one month.
(17) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	The beds have not been affected by frost—that is, the working has not been discontinued. No notes of temperature have been taken. But greater activity of insect life and better effluent have been noticed in summer than winter.
(18) Was any nuisance caused by the experimental works?	No; no complaints whatever. The effluent passing from the works has passed into the brook, and been used for steam-generating purposes. There has been some slight smell noticeable since the small subsidence tank was laid down; before no smell was perceptible.
(19) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	he works are still in operation, and I feel sure my Council would offer your Commission every facility if you thought it desirable to inspect the works.

Appendix 9C.

(20) Give particulars of any other observations of importance which were recorded.	I consider it desirable: 1. That a preliminary subsidence chamber and tanks be constructed to prevent grit and paper and solids getting on the surface of the beds and clogging them. 2. That storm water should be limited as far as possible from passing into beds which are intended to break up and liquefy solids, as the cool water has the effect of retarding the action of the beds, and that fine cinder filters or land for this purpose might with advantage be used. The beds work better after the season of rest. A black effluent from the first series will give a clear effluent from the second series, whereas a milky effluent from first gives often a milky effluent from second. The effluent in winter not quite so good as in summer. The fine beds should not have material of less mesh than ¼ in. 1 inch to ¼ inch works satisfactory.
(21) What inferences have been drawn from the experiment?	That it is not absolutely necessary to construct expensive concrete and brick beds where clay land is obtainable except for the detritus or settling tanks. The works, including Lowe Bank and Garswood, which deal with population of 2,500, cost £450, were constructed out of current rate. Of this amount, £150 was spent in wrought iron fencing and £20 in roads, leaving nett cost of works at £280. The results arrived at have encouraged my Council to extend the system, and beds of a similar nature have been constructed, to deal with a population of 10,000, and for which purpose 1¼ acres of beds have been provided, the cost of which will be £1,100, ; these beds will be working in the course of one month and no sewage has yet been put through them. An area of land is being provided at Garswood and Lowe Bank for storm water, and steps are being taken to take out all the storm water possible from the sewers.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	Yes, if required.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;	£110 per 1,000 of population, or, say 2s. 6d. per head.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	One man could look after works dealing with a population of 1,000, with slight help at times. One man would be required to attend on smaller works, which would increase the cost. It has cost for maintenance £60 per annum for Lowe Bank and Garswood Works, or about 6d. per head of population per annum.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tank" is intended to denote tanks which are used so that little or no "Septic" action is produced.

John W. Liversedge, Surveyor.
Signature of Officer under whose direction the experiment was conducted.

Form D.

Appendix 9C

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS. (SINGLE CONTACT.)

Name of authority	Burgess Hill Urban District Council.
Population of district	5,000.
Water supply per head of the population	18 gallons per day.
Estimated or measured dry weather flow of sewage	About 100,000 gallons per day.
Is any trade refuse taken into the sewers?	No.
If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Only partially excluded.
Officer under whom the experiment has been conducted	Surveyor E. Brown.
Name and qualification of chemist who has made the analyses.	R. A. Cripps, F.I.C.
(1) What is the capacity in gallons of the subsidence tanks?	750 gallons.
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	Usually filled in a week and emptied in a week.
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous when used. The tanks are in duplicate and one is in use while the other is emptied.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	No coarse beds.
(*b*) What was the depth of these beds?	
(*c*) What were the nature and size of the filtering material?	
(5) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	
(6) What was the water-holding capacity of the coarse beds at end of experiment?	
If the measurement was made after resting, please give the duration of the resting.	
(7) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	9,000 gallons.
(*b*) What was the depth of these beds?	3 ft. 6 in. deep.
(*c*) What were the nature and size of the filtering material?	Mainly furnace clinkers, some coke passed through a $\frac{1}{8}$-in. screen and rejected by a $\frac{1}{2}$-in. screen.
(8) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	This has not been done, but the capacity is very little reduced in six months' use.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	Not been measured.
(9) State method of working of contact beds, *i.e.*, number of fillings per day of 24 hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Worked automatically, average time of filling two hours, and worked in a set of four beds, each bed filled three times per day. (*a*) Average - - 2 hours. (*b*) „ - - 2 „ (*c*) „ - - $1\frac{1}{2}$ „ (*e*) „ - - $2\frac{1}{2}$ „
(10) State by what method the settled sewage was distributed on the beds.	Distributed by automatic gear through valves, pipes and channels.
(11) What was the average quantity of sewage in gallons dealt with daily?	About 100,000 gallons.
(12) Was the quantity of sewage dealt with increased in time of storm?	Yes.
If so, state to what extent, and how the results were affected by such increase.	More than doubled, but the results remain about the same, dilution of sewage compensates for the increase of flow.

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(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Only one analysis has been taken. No.
(14) Give (*a*) the only analysis of the final effluent from the beds.	Total solids - - - - - 81·42 parts per 100,000. Solids in suspension - - - 2·14 " " " Chlorine - - - - - 11·85 " " " Ammonia (N as) - - - 3·85 " " " Albuminoid ammonia - - ·24 " " " Oxygen absorbed in three hours ·554 " " " Nitrites - - - - - - very large traces. Nitrogen as nitrates - - ·447 parts per 100,000.
(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the farm.	101·42.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	2·14. No evidence.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	Total solids - - - - - 172·14 parts per 100,000. Solids in suspension - - 101·42 " " " Chlorine - - - - - 11·28 " " " Ammonia (as N) - - - 17·20 " " " Albuminoid ammonia - - 4·00 " " " Oxygen absorbed in three hours 8·03 " " " Nitrites - - - - - absent. Nitrogen as nitrates - - - "
(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	Beds have been working continuous for four months previous to the analysis being made.
(17) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	Was not taken, but notices effluent was often brighter on bright sunshiny days.
(18) Was any nuisance caused by the experimental works?	None.
(19) Is the experiment still proceeding? - - - - If so, may the Commission inspect the works, should they deem it desirable to do so?	The beds are still in use. Yes.
(20) Give particulars of any other observations of importance which were recorded.	These beds are used as a supplemental treatment to a clay sewage farm. It has been found that in summer or very dry weather the clay cracks and the purification was very imperfect, and the stream into which the effluent discharged became polluted, but since the introduction of the bacteria beds, through which all the effluent from the farm passes, the stream has been cleansed, and little, if any, evidence is now seen that a sewage effluent discharges into the stream.
(21) What inferences have been drawn from the experiment?	Up to the present date we have found the beds effect all that was expected, and we propose to continue them in connection with the sewage farm.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	The whole of the sewage is treated by this system.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	The beds cost 725*l*.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	No calculations made.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended o denote tanks which are used so that little or no "Septic" action is produced.

EDW. BROWN,
Signature of Officer under whose direction the experiment was conducted.

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Form D.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS.
(SINGLE CONTACT.)

Name of authority	Corporation of Croydon.

The following replies relate to South Norwood Farm only :—

Population of district	21,000 draining to this farm.
Water supply per head of the population	25 gallons per day.
Estimated dry weather flow of sewage	600,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Very little, excepting from slaughter-houses.
Is the storm, soil, or surface water, wholly or partially, excluded from the ordinary sewers?	Partially.
Officer under whom the experiment has been conducted	Mr. John Figg, the Farm Manager.
Name and qualification of chemist who has made the analyses.	Mr. Farmer, the Corporation Farm Analyst.

(1) What is the capacity in gallons of the subsidence tanks?	The open outfall sewers on the farm through which the sewage passes to the contact beds, and usually have about 25,000 gallons of sewage in them slowly passing to the beds.
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	About one cube yard a week, which is removed monthly.
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(4) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	From a test made in a measure by filling water into the ballast it held 50 per cent. of water.
(b) What was the depth of these beds?	3 ft. 10 in.
(c) What were the nature and size of the filtering material?	Burnt ballast rejected by a sieve with inch mesh.
(5) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No measurements have been taken; the level of the beds is too high to do this with any accuracy.
(6) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	No particulars taken.
(7) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	No fine beds constructed.
(b) What was the depth of these beds?	
(c) What were the nature and size of the filtering material?	
(8) (a) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(b) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of 24 hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Two fillings in 24 hours, but on Sundays only one filling. Times: (*a*) $1\frac{1}{3}$ hours, (*b*) 2 hours, (*c*) $1\frac{1}{3}$ hours, (*e*) $2\frac{1}{3}$ hours.
(10) State by what method the settled sewage was distributed on the beds.	By earthenware half-pipes on the top of the beds.
(11) What was the average quantity of sewage in gallons dealt with daily?	About 450,000 gallons

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(12) Was the quantity of sewage dealt with increased in time of storm?

If so, state to what extent, and how the results were affected by such increase.

No. At such times storm water passes through other sedimentary tanks, and then over the land by broad irrigation.

(13) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Analyses of the effluent are made weekly from one bed in rotation, and they are shaken before analyses.

(14) Give (*a*) the average of the analyses of the final effluent from the beds;

(*b*) the best analysis of the final effluent, and date when sample was taken; and

(*c*) the worst analysis of the final effluent, and date when sample was taken;

—	Oxygen absorbed		Chlorine.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Date.
	¼ hour.	4 hours.				
(*a*)* -	1·15	2·18	8·5	2·13	0·32	—
(*b*)* -	0·41	0·92	5·7	0·36	0·12	Nov. 2, 1899.
(*c*)* -	1·11	2·73	8·5	3·6	0·54	Dec. 24, 1900.

* Coarse bed.

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.

42·8.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

5·7. Sometimes slightly.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

Oxygen absorbed.		Chlorine.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.
¼ hour.	4 hours.			
3·82	7·01	8·7	8·09	1·01

(16) Between what dates was the experiment conducted?

If there were any periods of rest, state their duration.

The experimental bed has been in constant use since April 16th, 1898, with three partial rests of a fortnight each, when the bed was filled once a day instead of twice.

The other five beds have been in use from one to six months without a rest.

(17) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

None taken.

(18) Was any nuisance caused by the experimental works?

None.

(19) Is the experiment still proceeding? - - - -

If so, may the Commission inspect the works, should they deem it desirable to do so?

Permanent works have been constructed for three-fourths of the dry-weather flow. The works can be seen any time without any notice.

(20) Give particulars of any other observations of importance which were recorded.

The land upon which the effluent from the contact beds flows is a stiff soil overlying the London clay, the soil varying from 9 to 12 inches in thickness.

The solids from the sewage are now kept from covering the surface of the farm, allowing the soil to aerate, and the appearance of the farm is very much improved, as also the effluent from it.

(21) What inferences have been drawn from the experiment?

The single contact (coarse bed) is a most valuable assistance to broad irrigation, and enables an area of land to cleanse double the quantity of sewage that it would do without the contact beds.

(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

Our experience is only with one contact (coarse bed), the effluent still passing over the land in broad irrigation as it did before the contact beds were made.

(*a*) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.

(*a*) Our cost for the beds has been 2*s*. 6*d*. per head for construction.

(*b*) What would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.

(*b*) The cost of working the contact beds, including the extra pumping, will be about 1½*d*. per head per annum.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no Septic" action is produced.

T. Walker, Borough Engineer.
Signature of Officer under whose direction the experiment was conducted.

January 25th, 1901.

Form D.

PERMANENT WORKS FOR THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS (SINGLE CONTACT).

Appendix 9C.

Name of authority - - - - - - -	The Hunslet Rural District Council.
Population of part of district referred to - . - -	Estimated at 2,000.
Water supply per head of the population - - -	8 gallons per day.
Estimated or measured dry weather flow of sewage -	
Is any trade refuse taken into the sewers? - - - If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	No.
Is the storm, soil, or surface water, wholly or partially, excluded from the ordinary sewers?	Partially.
Officer under whom the works are conducted - - -	Dr. Buck, M.O.H., Rothwell, Leeds.
Name and qualification of chemist who has made the analyses.	None made.
(1) What is the capacity in gallons of the subsidence tanks?	20,310 gallons.
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	225 cubic ft. sludge weekly. Removed fortnightly.
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	
(*b*) What was the depth of those beds? - - -	5 feet.
(*c*) What were the nature and size of the filtering material?	Bottom, 1 ft. 6 in. - - 2½ in. broken stones. Middle, 2 ft. 0 in. - - Broken clinkers. Top, 1 ft. 6 in. - - Coke breeze.
(5) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	Only one class of beds.
(6) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(7) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	
(*c*) What were the nature and size of the filtering material?	
(8) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Filled in, 2 hours; standing full, 2 hours; emptying and resting, 4 hours.
(10) State by what method the settled sewage was distributed on the beds.	Channel and pipes from settling tanks. Wooden spouts across centre of contact beds.

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(11) What was the average quantity of sewage in gallons dealt with daily?	
(12) Was the quantity of sewage dealt with increased in time of storm?	Yes, very much.
If so, state to what extent, and how the results were affected by such increase.	
(13) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper, or allowed to clear by standing before being analysed.	None made.
(14) Give (*a*) the average of the analyses of the final effluent from the beds.	
(*b*) The best analysis of the final effluent, and date when sample was taken, and	
(*c*) The worst analysis of the final effluent, and date when sample was taken.	
(*d*) The average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.	
(*e*) The average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	
(15) Give a typical analysis of the crude sewage to which the experiment relates.	
(16) Between what dates was the experiment conducted?	Been working 4 or 5 years.
If there were any periods of rest, state their duration.	
(17) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	
(18) Was any nuisance caused by the works? - - -	No.
(19) Is the experiment still proceeding?	
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(20) Give particulars of any other observations of importance which were recorded.	West Riding Rivers Board Inspector has frequently expressed his satisfaction with the effluent.
(21) What inferences have been drawn from the experiment?	That the system, if properly worked, is very efficient in dealing with domestic sewage, but neglect in management would soon ruin the beds and render them worthless.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) What would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers?	Ten shillings per head.
(*b*) What would be the estimated annual cost per head of purifying the sewage of this system—excluding the annual repayment of any loan?	Sixpence.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

JOSEPH BUCK.

Signature of Officer under whose direction the experiment was conducted.

Form D.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS (DOUBLE CONTACT.)

Name of authority - - - - - - - - -	Keighley Corporation.
Population of district - - - - - - -	About 41,000.
Water supply per head of the population - - - -	About 32 gallons per day for domestic and trade purposes.
Estimated or measured dry weather flow of sewage- -	115,000 gallons per hour during daytime, or about $1\frac{3}{4}$ million gallons per day.
Is any trade refuse taken into the sewers? - - - -	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Woolcombers' suds, tanneries, yarn washing, magma or grease, dyewater, about 20 per cent.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially.
Officer under whom the experiment has been conducted.	Borough Engineer.
Name and qualification of chemist who has made the analyses.	Rimmington & Son, Chemists, Bradford; Richardson, City Analyst, Bradford.

(1) What is the capacity in gallons of the subsidence tanks?	About 9,000 gallons. *Note.*—The experimental tanks are on a small scale.
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	During the six months that the experiments have been tried there has been practically no accumulation of sludge.
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Intermittent.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	920 gallons at present.
(*b*) What was the depth of these beds? - - -	3 ft. 3 in. of coke.
(*c*) What was the size of the filtering material? -	Varying from 2 in. to $\frac{3}{4}$ in.
(5) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No measurements have been taken.
(6) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	*See* 5.
(7) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	920 gallons at present.
(*b*) What was the depth of these beds? - - -	3 ft. 6 in.
(*c*) What was the size of the filtering material? -	1 in. to $\frac{1}{4}$ in.
(8) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	No measurements have been taken.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	*See* 8.
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Three fillings per 24 hours. (*a*) 5 a.m., 1 p.m., and 9 p.m., or 8 hours. (*b*) 8 a.m., 5 p.m., and 1 a.m., or 3 hours full. (*c*) 5 minutes. (*e*) 5 hours empty or aerating.
(10) State by what method the settled sewage was distributed on the beds.	Through a 3 in. pipe into a wooden carrier 9 in wide and 6 in. deep, with grooves at sides.
(11) What was the average quantity of sewage in gallons dealt with daily?	Three times filling. 920 gallons × 3 = 2,760 gallons per day.
(12) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No.

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(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

(14) Give (*a*) the average of the analyses of the final effluent from the beds.

Samples have been sent to F. Rimmington & Son, Chemists, Bradford, and F. W. Richardson, City Analyst, Bradford, and copies of reports are enclosed.

Analytical Laboratory, 9, Bridge Street, Bradford, 17th August 1900.

Certificate of Analysis of two samples of Sewage Water received from W. H. Hopkinson, Esq., A.M.I.C.E., Borough Engineer, Keighley.

The results are stated in grains per gallon.

	Crude Sewage.	Effluent.
Suspended matter - - - -	4·76	1·27
Total solid matter - - - -	27·75	30·45
Organic and volatile matter -	9·21	5·91
Saline matter - - - - -	18·54	24·54
Chlorine - - - - - -	3·08	3·22
Free ammonia - - - - -	1·395	0·2247
Albuminoid ammonia - - -	0·196	0·0448
Oxygen absorbed in three hours -	1·432	0·316

(signed) *F. M. Rimmington & Son.*

"Crude Sewage" taken out of carrier.

"Effluent" after passing detritus tank, sedimentation tank and 1st and 2nd contact beds.

City Analyst's Office, Bradford, 23rd August 1900.

Analytical Report upon two samples of Sewage from W. H. Hopkinson, Esq., Borough Engineer, Keighley. received 21st August 1900.

Grains per Gallon.

	Crude Sewage.	Effluent.
Total sediment - - - -	10·0	trace
In solution:		
Total solids - - - - - -	30·0	·46
Alkalinity equal to sulphuric acid	12·3	7·85
Oxygen absorbed in four hours -	·875	·150
Free ammonia - - - - -	1·05	·140
Albuminoid ammonia - - -	·455	·155

Percentage Purification effected on—

(1) The absorbed oxygen - - - -	82·6
(2) The albuminoid ammonia - - -	66·0
Average - - - -	74·3

The effluent shows a high degree of purification.

(Signed) *F. W. Richardson.*

"Crude Sewage" taken out of carrier.

"Effluent" after passing detritus tank, sedimentation tank and 1st and 2nd contact beds.

Analytical Laboratory, 9, Bridge Street, Bradford, 28th August 1900.

Certificate of Analysis of two samples of Sewage Water received from W. H. Hopkinson, Esq., A.M.I.C.E., Borough Engineer, Keighley.

The results are stated in Grains per Gallon.

	No. 1. 24 Aug.	No. 2. 25 Aug.
Suspended matter - - - -	23·15	0·49
Total solid matter - - - -	52·21	44·05
Organic and volatile matter -	20·59	9·05
Saline matter - - - - -	31·62	35·00
Chlorine - - - - - -	3·64	4·34
Free ammonia - - - - -	1·533	2·051
Albuminoid ammonia - - -	0·595	0·2828
Oxygen absorbed in three hours -	3·708	1·524

(Signed) *F. M. Rimmington & Son.*

No. 1 crude sewage taken out of carrier.

No. 2 effluent from No. 2 intermittent filtration bed on contract drawing and 24 hours after crude sewage was put into the surface of the bed.

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Analytical Laboratory, 9, Bridge Street. Bradford, 8th September 1900.

Certificate of Analysis of two samples of Sewage Water received from W. H. Hopkinson, Esq., A.M.I.C.E., Borough Engineer, Keighley.

The results are stated in Grains per Gallon.

	No. 1.	No. 2.
Suspended matter - - -	10·36	1·61
Total solid matter - - -	39·55	28·43
Organic and volatile matter -	17·50	9·89
Saline matter - - - -	22·05	19·54
Chlorine - - - - -	3·37	2·52
Free ammonia - - - -	1·477	0·616
Albuminoid ammonia - - -	0·539	0·2142
Oxygen absorbed in three hours -	2·013	0·7364

(Signed) *F. M. Rimmington & Son.*

No. 1 is a sample of crude sewage made up from quantities taken every hour.

No. 2 is a sample of effluent made up from quantities taken every hour from No. 15 intermittent filtration bed on contract drawings.

Analytical Laboratory, 9, Bridge Street, Bradford, 3rd October 1900.

Certificate of Analysis of two samples of Sewage Water, received from W. H. Hopkinson, Esq., A.M.I.C.E., Borough Engineer, Keighley.

The results are stated in Grains per Gallon.

	No. 1.	No. 2.
Suspended matter - - -	0·15	4·03
Total solid matter - - -	27·65	27·27
Organic and volatile matter -	11·94	5·79
Saline matter - - - -	15·71	21·48
Chlorine - - - - -	5·95	4·34
Free ammonia - - - -	3·178	1·05
Albuminoid ammonia - - -	0·287	0·182
Oxygen absorbed in three hours -	4·281	0·957

(Signed) *F. M. Rimmington & Son.*

No. 1 is crude sewage with a quantity of dye-water.

No. 2 is effluent after passing detritus tank, sedimentation tank and 1st and 2nd contact beds.

Analytical Laboratory, 9, Bridge Street, Bradford, 6th December 1900.

Certificate of Analysis of two samples of Sewage Water, labelled No. 1 and No. 2, received from W. H. Hopkinson, Esq., A.M.I.C.E., Borough Engineer, Keighley.

The results are stated in Grains per Gallon.

	No. 1.	No. 2.
Suspended matter - - -	12·35	nil
Total solid matter - - -	47·86	33·31
Organic and volatile matter -	26·24	8·58
Saline matter - - - -	21·62	24·73
Chlorine - - - - -	3·78	3·64
Free ammonia - - - -	1·288	0·217
Albuminoid ammonia - - -	0·546	0·091
Oxygen absorbed in three hours -	3·815	0·785

(Signed) *F. M. Rimmington & Son.*

No. 1 is crude sewage taken from carrier.

No. 2 is effluent after passing detritus tank, sedimentation tank and 1st and 2nd contact beds, but allowing five minutes to discharge from 1st and 2nd contact beds.

(*b*) The best analysis of the final effluent and date when sample was taken, and	*See* 14.
(*c*) The worst analysis of the final effluent and date when sample was taken.	*See* 14.
(*d*) The average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.	*See* 14.
(*e*) The average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	*See* 14. Samples can be examined. There are final samples that do not smell.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	*See* Analyses No. 1, 2, 5, and 6.
(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	Since August of 1900.

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(17) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	None taken.
(18) Was any nuisance caused by the experimental works?	No. If a sample of the bed be taken out, there is only an *earthy* smell.
(19) Is the experiment still proceeding? - - - -	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes, with pleasure.
(20) Give particulars of any other observations of importance which were recorded.	
(21) What inferences have been drawn from the experiment?	That the effluent from the experimental tanks is good enough to go into the river without further treatment, and the cost of maintenance would be considerably less.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	It is considered practicable.
(*a*) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	£26,000.
(*b*) What would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	Estimated at £500.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic action is produced.

W. H. Hopkinson, A.M.Inst.C.E., Borough Engineer.
Signature of Officer under whose directio
the experiment was conducted.

Form D.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS.

Northern Outfall—Coke beds dealing with rapidly sedimented crude sewage.

Name of authority - - - - - - -	London County Council.
Population of district - - - - - - - (Sewage derived from London north of Thames.)	3,251,974 (1896).
Water supply per head of the population - - -	34·8 gallons per day (1900).
Estimated or measured dry weather flow of sewage -	123,000,000 gallons per day (1900).
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Trade refuse from districts drained is taken into sewers. Quantity not known.
Is the storm, soil or surface weather, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted -	Professor Clowes, D.Sc.
Name and qualification of chemist who has made the analyses.	Mr. E. B. Pike.

(1) What is the capacity in gallons of the subsidence tanks?	1,000 gallons. Filled to within 6 inches of the top. The capacity is 950 gallons.
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	About 9 gallons of sludge containing 89·5 per cent. of moisture, collected in each of the two subsidence tanks. The sludge was removed only once and for experimental purposes. The tanks had then been in use for 13 weeks.
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Intermittent. In these experiments two subsidence tanks were used and filled up each time simultaneously with similar quality sewage. The settled sewage from each tank was led into a single contact bed, consisting in one case of coarse coke fragments and in the other of fine coke fragments.
(4) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	The capacity of the coarse bed was 41·7 per cent. of the tank capacity without the coke. This bed had been in use previously as a "secondary" bed.
(b) What was the depth of these beds?	6 feet.
(c) What were the nature and size of the filtering material?	Fragments of sifted coke of such a size as would pass a 2-inch and would be rejected by a ½-inch mesh.
(5) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not. Each of these tests was made after the bed had been resting about 9 hours.	see below

1900.	Capacity.
20 November - -	38·5 per cent. of capacity of tank without coke.
27 " - - -	38·8 "
4 December - - -	38·5 "
11 " - - -	37·8 "
18 " - - -	36·1 "
1901.	
1 January - - -	35·3 "
15 " - - -	34·7 "
23 " - - -	34·7 "
30 " - - -	35·4 "
5 February - - -	32·7 "
12 March - - -	32·0 "
4 June - - - -	32·2 "
2 July - - - -	34·0 "
30 " - - - -	33·3 "

(6) What was the water-holding capacity of the coarse beds at end of experiment?	30 July, 1901. 33·3 per cent.
If the measurement was made after resting, please give the duration of the resting.	After 9 hours resting.
(7) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	The capacity of the fine bed was 40·3 per cent. of the capacity of the tank without the coke. This bed had been in use previously as a "secondary" bed.
(b) What was the depth of these beds? - -	Six feet.
(c) What were the nature and size of the filtering material?	Sifted coke fragments of such a size as would pass a ½-inch mesh and would be rejected by a $\frac{1}{16}$-inch mesh.

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(8) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

All these capacity tests were made after the bed had been resting about 9 hours.

1900.	Capacity.
20 November - -	38·5 per cent. of capacity of empty tank without coke.
27 " - - -	38·8 "
4 December - - -	37·5 "
11 " - - -	37·8 "
18 " - - -	35·4 "
1901.	
1 January - - -	33·3 "
15 " - - -	32·6 "
23 " - - -	31·2 "
30 " - - -	30·6 "
5 February - - -	29·2 "
12 March - - -	26·7 "
4 June - - -	25·0 "
18 " - - -	22·9 "
2 July - - -	25·0 ,
30 " - - -	25·3 "

(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.

25·3 per cent. (30th July, 1901) after resting 9 hours.

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

One or two fillings per day.

(10) State by what method the settled sewage was distributed on the beds.

2-foot fall on to perforated boards 2 feet above the surface of the bed.

(11) What was the average quantity of sewage in gallons dealt with daily?

One filling 200 gallons } about.
Two fillings 400 " }

(12) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Average samples analysed daily.

Samples filtered except that used for estimating the total putrescible matter present.

(14) Give (*a*) the average of the analyses of the final effluent from the beds.

Averages of estimations made during the period 7th Nov., 1900-6th Aug., 1901:—

	Coarse bed.	Fine bed.
Solids in suspension - - -	10·	3·2
Solids in solution - - -	93·3	96·3
Oxygen absorbed from permanganate in four hours at 80° F.:		
By the total putrescible matter.	5·100	3·358
By the dissolved putrescible matter.	3·320	2·604
Nitrous nitrogen - - -	0·036	0·05674
Nitric nitrogen - - -	0·752	1·2931

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken.

	Coarse bed. 27 July, 1901.	Fine bed. 27 July, 1901.
(*b*) Suspended solids - -	10·	4·
Oxygen absorbed from permanganate in four hours at 80° F.:		
By total putrescible matter.	3·724	1·9610
By dissolved putrescible matter.	1·372	0·980
Nitrous nitrogen - -	nil	0·040
Nitric nitrogen - -	1·1245	1·5395
	28 June, 1901.	18 Jan., 1901.
(*c*) Suspended solids - -	44·	2·
Oxygen absorbed from permanganate in four hours at 80° F.:		
By total putrescible matter.	12·800	4·000
By dissolved putrescible matter.	7·600	3·800
Nitrous nitrogen - -	0·090	0·050
Nitric nitrogen - -	5·4079	1·0663

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(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;

17·7 parts per 100,000.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Coarse bed.	Fine bed.
10·0	3·2

The effluents did not putresce in the laboratory.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

Average for the period 7th Nov., 1900–6th Aug., 1901.

	Sewage supplied to settling tank worked in connection with the	
	Coarse bed.	Fine bed.
Suspended solids - - - -	66·5	67·0
Oxygen absorbed from permanganate in four hours at 80° F.:		
By the total putrescible matter.	12·933	12·829
By the dissolved putrescible matter.	6·882	6·648
Nitrous nitrogen - - -	0·0115	0·0106
Nitric nitrogen - - -	0·0412	0·0326

(16) Between what dates was the experiment conducted? If there were any periods of rest, state their duration

7th Nov., 1900—6th Aug., 1901.

Series including tank and fine bed:—	Series including tank and coarse bed:—
12 days through frost.	10 days through frost.
36 single days at intervals.	15 single days at intervals.
Fine beds only:—	Coarse bed only:—
2 single days.	1 day.

Both settling tanks and both beds.
Every Sunday and
3 days at Christmas, 1900.
5 „ „ Easter, 1901.
3 „ „ Whitsuntide, 1901.
2 „ „ August Bank Holiday, 1901.

(17) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

None made.

(18) Was any nuisance caused by the experimental works?

No.

(19) Is the experiment still proceeding?

No.

If so, may the Commission inspect the works, should they deem it desirable to do so?

(20) Give particulars of any other observations of importance which were recorded.

(21) What inferences have been drawn from the experiment?

(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

This system appears perfectly practicable and a non-putrescible effluent of satisfactory character would be obtained by its adoption.

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.

A somewhat heavy expenditure would be incurred by pumping the effluent into the river during high water.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

FRANK CLOWES.

Signature of Officer under whose direction the experiment was conducted.
Chief Chemist to the London County Council.

Appendix 9C. Form D.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS.

Name of authority - - - - - - - -	Manchester.
Population of district - - - - - - -	516,000.
Water supply per head of the population - - -	
Estimated or measured dry weather flow of sewage -	21,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Mostly enter the sewers.
Is the storm, soil, or surface water, wholly or partially, excluded from the ordinary sewers?	
Officer under whom the experiment has been conducted.	Gilbert J. Fowler, M.Sc., F.I.
Name and qualification of chemist who has made the analyses.	
(1) What is the capacity in gallons of the subsidence tanks?	
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Intermittent.
(4) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	
(b) What was the depth of this bed?	3 feet.
(c) What was the nature and size of the filtering material?	Screened clinker. Rough material round the drain-pipes. Material uniform throughout the bed. Passed 3-inch mesh and rejected by 1-inch mesh.
(5) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse bed, stating in each case whether the measurement was made after resting or not.	See Bed A table below.
(6) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(b) What was the depth of this bed? - - -	Three feet.
(c) What was the nature and size of the filtering material?	Screened clinker. Rough material round the drain-pipes. Material uniform throughout the bed. Passed 1 inch mesh, rejected by ¼ inch mesh.
(8) (a) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	See Bed B table below.
(b) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	

Bed A.

Date.	Capacity in Gallons.	Remarks.
12th Sept. 1898 -	5,688	
27th Oct. „ -	4,800	4¾ hours rest.
15th Nov. „ -	4,530	3 hours rest.

Bed B.

Date.	Capacity in Gallons.	Remarks.
9th Sept. - -	5,688	Material quite dry.
10 „ - -	5,004	2½ hours rest.
16th Nov. - -	4,530	3 hours rest. Drainage pipes full.

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

Date. 1898	No. of fillings.	Cycle.
September 21st	1	(*a*) $\frac{3}{4}$ hour, (*b*) 2 hours, (*c*) $\frac{3}{4}$ hour, (*e*) remainder of time.
Sept. 21 to Oct. 26	2	Primary bed filled at 8 a.m. and 2 p.m. Working cycle as above.
Oct. 26 to Nov. 16	3	(*a*) $\frac{3}{4}$ hour, (*b*) 1 hour, (*c*) $\frac{3}{4}$ hour, (*e*) 4 hours. (*a*) $\frac{3}{4}$ hour, (*b*) 2 hours, (*c*) $\frac{3}{4}$ hour, (*e*) $2\frac{1}{2}$ hours. (*a*) $\frac{3}{4}$ hour, (*b*) 2 hours, (*c*) hour, (*e*) 8 hours.

(10) State by what method the settled sewage was distributed on the beds.

By means of wooden shoots perforated at the bottom of the sides.

(11) What was the average quantity of sewage in gallons dealt with daily?

9,000 (allowing for Sunday's rest).

(12) Was the quantity of sewage dealt with increased in time of storm. If so, state to what extent, and how the results were affected by such increase.

No.

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Daily, except Sundays. Samples shaken before analysis.

(14) Give (*a*) the average of the analyses of the final effluent from the beds;

The following numbers are the average of daily analyses for the different periods stated, of the effluent from the Secondary Bed (B):—

Date.	Four Hours Oxygen Absorption.	Incubator Test. 3 mins. Oxygen Absorption. Before.	Incubator Test. 3 mins. Oxygen Absorption. After.	Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
Sept. 14th-21st, 1898 - - - (1 filling per day).	2·47	1·44	2·03	43-6	1·[illegible]6	·14	·059	nil.	15·4
Sept. 21st-Oct. 26th, 1898 - - (2 fillings per day).	1·63	·90	·93	$27\frac{1}{2}$-68	1·10	·117	·033	·333	14·6
Oct. 26th-Nov. 16th, 1898 - - (3 fillings per day).	1·47	·70	·68	$10\frac{1}{2}$-52	0·77	·096	·016	·368	14·1

(*b*) the best analysis of the final effluent and date when sample was taken; and

(*c*) the worst analysis of the final effluent and date when sample was taken;

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

(15) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily analyses of *Settled Sewage*, for the quarter ending December 29th, 1898:—

4 hours Oxygen Absorption - - -	7·21
3 minutes Oxygen Absorption - -	3·86
Ammoniacal Nitrogen - - - - -	2·04
Albuminoid Nitrogen - - - - -	·33
Chlorine - - - - - - - -	16·0

(16) Between what dates was the experiment conducted?

September 14th-November 16th, 1898.

If there were any periods of rest, state their duration.

The beds rested on Sundays; no other periods of rest.

(17) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

(18) Was any nuisance caused by the experimental works?

No.

(19) Is the experiment still proceeding? - - - -

No.

If so, may the Commission inspect the works, should they deem it desirable to do so?

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(20) Give particulars of any other observations of importance which were recorded.	The following substances have been definitely recognised in the sewage which has at various times passed on filters, viz. :— Iron pickling refuse. Dye refuse. Carbolic acid. Sulpho-cyanates. The Iron Pickling Refuse (originally ferrous chloride) is completely oxidised in passing through the filters, some hydrated oxide of iron remaining in the filters. Dye Refuse—The colour is to a large extent, though not completely, discharged. Carbolic Acid—This appears to be oxidised in the filters. In no case has the presence of manufacturing waste shewn a marked tendency to render the purification less effective.
(21) What inferences have been drawn from the experiment?	Apparently it is not certain that non-putrefactive filtrate can invariably be obtained by treatment of fresh sewage by double contact, though experiences point out that the results would have improved on further working.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state (*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers; (*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no "Septic" action is produced.

Gilbert J. Fowler,

Signature of Officer under whose direction the experiment was conducted.

Form D.

Appendix 9C

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS. (SINGLE CONTACT.)

Name of authority - - - - - - - -	Oldham Corporation.
Population of district - - - - - - -	155,865.
Water supply per head of the population - - -	$22\frac{1}{2}$ gallons per day.
Estimated or measured dry weather flow of sewage -	4,000,000 gallons per day (estimated).
Is any trade refuse taken into the sewers? If so, state from what process it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Yes. Tripe-boiling refuse, brewing refuse, and foul water from lodges of cotton mills; the latter is the worst we have to deal with, but the total quantity of trade refuse is a negligeable quantity.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	$\frac{1}{4}$ inch, partially excluded.
Officer under whom the experiment has been conducted -	Dr. James B. Wilkinson, Medical Officer of Health.
Name and qualification of chemist who has made the analyses.	A. S. Wylie.
(1) What is the capacity in gallons of the subsidence tanks?	2,116,800 gallons, *i.e.*, 12 tanks each holding 176,400.
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	Unable to state weekly quantity, as each tank was working on an average three months before it was cleaned out. At the end of that time the sludge stood in the tank to a depth of 2 ft. 4 in. About 10,500 cubic feet of wet sludge.
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	Cubic capacity estimated at 40 per cent.
(*b*) What was the depth of these beds? - - -	From 2ft. to 2 ft. 9 in.
(*c*) What were the nature and size of the filtering material?	All the filters were made of furnace clinkers, all pieces which passed through a $\frac{1}{4}$ in. screen were rejected. Material was not graded in filters.
(5) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No observations made.
(6) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	Experiment still in progress.
(7) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	No fine beds used in experiments
(*b*) What was the depth of these beds?	
(*c*) What were the nature and size of the filtering material?	
(8) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Each bed is filled twice in 24 hours. (*a*) Filling occupied from $\frac{1}{2}$ to $\frac{3}{4}$ of an hour. (*b*) Standing full—two or three hours. (*c*) Emptying—about two hours. (*e*) Resting—interval between 1st and 2nd filling, two hours at least, sometimes more.

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(10) State by what method the settled sewage was distributed on the beds.	Distributed over the beds by means of wooden carriers.
(11) What was the average quantity of sewage in gallons dealt with daily?	484,000 gallons per acre.
(12) Was the quantity of sewage dealt with increased in time of storm?	No.
Is so, state to what extent, and how the results were affected by such increase.	
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Samples are taken daily and are analysed the day following. Samples are *not* filtered through filter paper, and are *not* allowed to clear by standing. Each sample is well shaken before being analysed.
(14) Give (*a*) the average of the analyses of the final effluent from the beds;	0·9 of a grain per 100,000, absorbed in 4 hours test. 1·49 „ „ ammoniacal nitrogen. 0·19 „ „ albuminoid nitrogen. 0·4 „ „ nitric nitrogen. Chlorine varied of course according to strength of sewage, but there was no appreciable reduction on filtration.
(*b*) the best analysis of the final effluent and date when sample was taken; and	5th November 1900—·11 of a grain per 100,000, oxygen absorbed in 4 hours test.
(*c*) the worst analysis of the final effluent and date when sample was taken;	18th July 1900—2·05 grains per 100,000, oxygen absorbed in 4 hours test.
(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;	No estimations of solids in suspension have been made.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Samples of the final effluent are regularly incubated, and are not putrescible on the whole. During very hot weather, owing to the tank effluent becoming septic, there are occasionally samples which become putrescent.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	4th July 1900. (see table below)

4th July 1900.

Oxygen absorbed in 4 hours test.	Ammoniacal nitrogen.	Albuminoid nitrogen.	Chlorine.
5·65	3·5	1·2	Not estimated.
	parts per 100,000.		

(16) Between what dates was the experiment conducted?	From the beginning of 1899, and the process is still going on.
If there were any periods of rest, state their duration.	Yes. Periods of rest are every Sunday, and also from 20 to 60 days in the year. Longest period about a fortnight at once.
(17) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	No observations made.
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(20) Give particulars of any other observations of importance which were recorded.	17th December 1900. Owing to the "Beer Poisoning Epidemic" about 200 barrels of beer were turned into the sewer on one day, and the figures went up to the following numbers on that date. Oxygen absorbed in 4 hours test, grains per 100,000: Tank effluent, 13·2 grains per 100,000. Filters, from 1·73 to 4·3 grains per 100,000. and nitrification ceased for almost a week. After a long period of rest the filtrate is heavily charged with nitrates. One sample gave 8·6 grains per 100,000.
(21) What inferences have been drawn from the experiment?	That this method of treatment will satisfactorily purify the sewage of Oldham, provided a tank effluent can be obtained which does not become septic in warm weather. This can be obtained by sufficient sludge-pressing accommodation, so that the subsidence tanks can be cleaned out more frequently. The tanks are liable to become extremely foul in summer, with a very large quantity of solids in suspension. The change from a comparatively weak tank effluent in winter to a highly septic tank effluent in summer, has a bad effect on the purifying powers of the filter. In some cases only one filling per 24 hours has been dealt with. The inference from this is, that in summer a considerable quantity of solid organic material is treated in the filter beds, which in winter is deposited as sludge.

(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	Yes. It it is intended to treat it by this method.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers ;	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	Cannot say at present.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;

Albuminoid nitrogen ;

Nitrous nitrogen ;

Nitric nitrogen ;

Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no septic" action is produced.

JAMES B. WILKINSON, M.D., C.M., D.P.H.,
Medical Officer of Health.

Signature of Officer under whose direction
the experiment was conducted.

Appendix 9C. Form D.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority - - - - - - - -	Corporation of Oswestry.
Population of district - - - - - - -	100,000.
Water supply per head of the population - - -	21 gallons per day.
Estimated or measured dry weather flow of sewage -	June and July, 1900, 387,000 gallons per day.
Is any trade refuse taken into the sewers? - - - If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Yes; Brewery, Tannery, and Fellmongers. Probably one-sixth.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted -	G. William Lacey, Borough Engineer and Surveyor.
Name and qualification of chemist who has made the analyses.	G. William Lacey, Borough Engineer and Surveyor.

(1) What is the capacity in gallons of the subsidence tanks?	56,000.
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	About 200 cubic ft. per week removed at from 8 to 10 weeks intervals.
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	Difficult to say exactly on account of the absorption of the earthen banks and floors. Approximately for the 8 beds in use 240,000 gallons.
(*b*) What was the depth of these beds? - - -	4 ft. 6 in.
(*c*) What were the nature and size of the filtering material?	Cinders $\frac{3}{8}$ in. to $1\frac{1}{2}$ in.
(5) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	Gaugings on a 24-hour diagram of the flow of sewage are taken almost daily, and special gaugings have been taken periodically to ascertain the capacity of the coarse beds. Taken under the ordinary working conditions of periodical rest.
(6) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	The capacity at the present time of the 8 beds in work is about 162,000 gallons. Loss 30 per cent. No. On ordinary working conditions.
(7) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds, when filled with the filtering material?	Not gauged. Approximately (8 beds) 168,000.
(*b*) What was the depth of these beds? - - -	4 ft. 6 in.
(*c*) What were the nature and size of the filtering material?	Cinders $\frac{3}{8}$ in. to 1 in.
(8) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	At the present time, so far as can be judged, the loss of capacity is exceedingly small.
(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	This varies with the rate of flow. It will average not quite 3 fillings per day. Sometimes of course more and sometimes less. If three fillings per day, each bed as follows: filling 1 hour, standing full 2 hours, emptying 1 hour, resting 4 hours. Every bed has one week's entire rest in nine.

(10) State by what method the settled sewage was distributed on the beds.	From a central automatic valve arrangement over wood troughs. Four distributing troughs to each bed.
(11) What was the average quantity of sewage in gallons dealt with daily?	440,000 (1900).
(12) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	Yes, considerably. Quantities treated have ranged up to 783,000 gallons per day. Effluents during very heavy storms somewhat turbid. The beds have not been injuriously affected thereby.
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Various intervals. Nearly every month since works completed. Sometimes several times a week. The analyses are as a rule made the day following the taking the samples. Samples not filtered.

(14) Give (*a*) the average of the analyses of the final effluent from the beds.

	parts per 100,000.
Chlorine	10·4
Free ammonia	·557
Albuminoid ammonia	·183
Oxygen absorbed in 20 minutes	·41

This is the average of 55 analyses taken from July 1899 to January 1901. The average percentage of purification over the whole period being albuminoid ammonia 89·5, and oxygen absorbed 88·4.

(*b*) the best analyses of the final effluent and date when sample was taken, and

7th November, 1899.

	parts per 100,000.
Chlorine	6·95
Free ammonia	·36
Albuminoid ammonia	·078
Oxygen absorbed in 20 minutes.	·30

(*c*) the worst analyses of the final effluent and date when sample was taken.

11th October, 1900.

	parts per 100,000.
Chlorine	9·3
Free ammonia	·48
Albuminoid ammonia	·408
Oxygen absorbed in 20 minutes	·54

Note.—The above is the only basis on which the analyses have been made.

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.	Not obtained.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Not obtained. Effluents have been kept for two years without signs of putrescence.

(15) Give a typical analysis of the crude sewage to which the experiment relates.

10th April, 1900.

	parts per 100,000.
Chlorine	10·00
Free ammonia	5·1
Albuminoid ammonia	1·92
Oxygen absorbed in 20 minutes	3·6

(16) Between what dates was the experiment conducted? If there were any periods of rest state their duration.	In July 1896 small experimental beds were constructed by the late Borough Engineer, and in November 1897 the permanent beds were commenced and finally completed in June 1899, and have been in constant operation ever since.

(17) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

Some records during February 1901.

Air.	Sewage.	Bed (midway).
Degrees.	Degrees.	Degrees.
40	42	40
42	44	44
42	46	41
34	42	38
30	41	34
32	43	34
33	42	38
35	42	36

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(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding? - - -	The works now in operation and which have been for two years past are permanent, and not experimental.
If so, may the Commission inspect the works should they deem it desirable to do so?	Yes.
(20) Give particulars of any other observations of importance which were recorded.	
(21) What inferences have been drawn from the experiment?	It is clearly demonstrated here that the sewage can be efficiently treated on the bacterial system.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	This has been done.
(*a*) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	The works have cost £2,000, which is equal to 4*s.* per head of population.
(*b*) What would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	Sixpence per head including sludge disposal.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

G. William Lacey, Borough Engineer and Surveyor.

Signature of Officer under whose direction the experiment was conducted.

Form D. Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority - - - - - - - -	Slough Urban Council.
Population of district - - - - - - -	About 7,000.
Water supply per head of the population : - - -	22 gallons per day.
Estimated or measured dry weather flow of sewage -	180,000 gallons per day.
Is any trade refuse taken into the sewers? - - -	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Elliman's Embrocation Works (only small quantities of refuse received).
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially.
Officer under whom the experiment has been conducted.	W. W. Cooper, surveyor, Slough.
Name and qualification of chemist who has made the analyses.	W. W. Fisher, county analyst, Oxford.

(1) What is the capacity in gallons of the storage tanks?	About 72,000 gallons.
(2) State what quantity of sludge was produced weekly in the storage tanks, and at what intervals the sludge was removed.	The tanks are used as storage tanks, and any sludge that accumulates is passed through the pumps to the farm.
(3) State whether the flow of sewage through the storage tanks was continuous or intermittent.	Continuous into; but only continuous through when the pumps are being worked.
(4) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	240 gallons.
(b) What was the depth of these beds? - - -	Two small beds, 3 ft. deep × 4 ft. × 4 ft.
(c) What were the nature and size of the filtering material?	Screened boiler ashes or clinker. 1 coarse bed, 1 fine bed.
(5) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	240 gallons per day. The 2 beds were filled twice a day for 6 days per week only as follows:— Time filling coarse bed - - - ½ an hour „ standing full - - - - - 2 hours „ emptying - - - - - ½ an hour „ empty - - - - - - 2 hours The effluent from coarse bed discharged on to fine bed, which was worked on the same system. The quantity of crude sewage treated per day was 240 gallons.
(6) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	Not more than one-half the original capacity.
(7) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	240 gallons per day.
(b) What was the depth of these beds?	3 feet.
(c) What were the nature and size of the filtering material?	Screened boiler ashes or clinker.
(8) (a) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	

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(b) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting. — Less than one half of original capacity.

(9) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (a) filling, (b) standing full, (c) emptying, and (e) resting. — See answer to query 5.

(10) State by what method the settled sewage was distributed on the beds. — Wooden troughs.

(11) What was the average quantity of sewage in gallons dealt with daily? — About 200 gallons.

(12) Was the quantity of sewage dealt with increased in time of storm? — No.

If so, state to what extent, and how the results were affected by such increase.

(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed. — Only one analysis.

Reference No. 2973.

To the Urban District Council, Slough.

Report on a sample of Effluent Water.

Received 18th July 1899,

From Mr. W. W. Cooper.

Effluent from Bacteria Bed.

Appearance :—Very slightly turbid.
Sediment :—Small.
Odour :—None. Sulphuretted hydrogen. 0.
Colour after filtering :—Nearly colourless.

The results of the analysis are stated in grains per gallon.

Total solid matter in suspension :—Not determined.

Mineral matter in suspension :—Not determined.

Organic and volatile matter :—Not determined.

	Grains.
Total dissolved solid matter - - -	65·8
Chlorine as chlorides - - - - - -	9·1
equals common salt - - - - - -	15·0
Ammonia free and saline - - -	1·37
Albuminoid ammonia - - - - -	0·058
Nitrogen as nitrates and nitrites - - -	3·15
equals nitric acid - - - - - -	0·1
Oxygen absorbed by organic matter in three hours - - - - - - - -	0·360

Remarks :—The effluent is nearly free from suspended matters, is without odour and nearly colourless, the proportion of organic matter estimated by albuminoid ammonia and oxygen absorbed is well below the standards for such discharges.

The large amount of nitrates shows an active healthy condition of the bacteria bed. The effluent is very satisfactory.

(Signed) ***W. W. Fisher***, F.I.C.,
Public Analyst for Oxford, Bucks, &c.

Oxford, 31st July 1899.

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(14) Give (a) the average of the analyses of the final effluent from the beds.

(b) the best analysis of the final effluent and date when sample was taken, and

(c) the worst analysis of the final effluent and date when sample was taken.

(d) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.

(e) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

(15) Give a typical analysis of the crude sewage to which the experiment relates. — Not taken.

(16) Between what dates was the experiment conducted? If there were any periods of rest state their duration. — March 22nd, 1899 to March 14th, 1900. Beds actually worked 266 days

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(17) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding?	No.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(20) Give particulars of any other observations of importance which were recorded.	On the whole, good effluents were obtained.
(21) What inferences have been drawn from the experiment?	Screened boiler ashes are not a suitable material. The sewage causes it to disintegrate, and by so doing the coarse bed becomes more readily choked. That subsidence tanks are advisable.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	Not estimated.
(a) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	
(b) What would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

W. W. Cooper, Surveyor.

Signature of Officer under whose direction the experiment was conducted

Appendix 9C.

Form D.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS AND CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority - - - - - - - -	Stanley Urban District, Co. Durham.
Population of district - - - - - - - -	(South Moor.) 4,560.
Water supply per head of the population - - -	Ten gallons per day.
Estimated or measured dry weather flow of sewage -	45,000 gallons per day.
Is any trade refuse taken into the sewers? - - -	No.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted -	T. Eustace Hill, M.B., B.Sc., F.I.C., Member of Society Public Analysts, County Medical Officer of Health.
Name and qualification of chemist who has made the analyses.	- - - ditto - - ditto.

(1) What is the capacity in gallons of the subsidence tanks?	24,360.
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	About 8 to 9 cwt. per week. Once in 2 months sludge is removed.
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent	Intermittent.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	Notes as to this mislaid. No appreciable reduction in capacity up to date.
(*b*) What was the depth of these beds? - - -	Rough beds 4 feet 6 inches deep. Fine beds 3 feet deep.
(*c*) What were the nature and size of the filtering material?	Rough beds. Coke breeze and clinkers from 1½ to 3 inches. Fine beds. Coke breeze, screened by ⅜-inch screen.
(5) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No experiments made.
(6) What was the water-holding capacity of the coarse beds at end of experiment?	No experiments made.
If the measurement was made after resting, please give the duration of the resting.	
(7) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	Not estimated.
(*b*) What was the depth of these beds? - - -	3 feet.
(*c*) What were the nature and size of the filtering material?	Coke breeze, screened by ⅜-inch screen
(8) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	Not taken.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	

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(9) State method of working of contact beds, *i.e.* number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	
) State by what method the settled sewage was distributed on the beds.	Conveyed by longitudinal channels, but not necessary. Fine beds, sewage run on and sinks in.
(11) What was the average quantity of sewage n gallons dealt with daily?	32,520 for 12 hours.
(12) Was the quantity of sewage dealt with increased in time of storm?	Yes.
If so, state to what extent, and how the results were affected by such increase.	
(13) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	From February 1899 to February 1901, 53 samples of fine tank effluent were analysed. The samples were not filtered before being analysed, as none of them contained any appreciable quantity of suspended matter.
(14) Give (*a*) the average of the analyses of the final effluent from the beds;	The average of 53 samples was as follows, in parts per 100,000.

		*
Free ammonia - - - -	2·897	1·549
Organic ammonia - - - -	0·141	0·072
Oxygen absorbed in three hours at 80° Fahr. - - - - - -	0·362	0·226
Chlorine as chlorides - - -	11·20	10·70
Total solid matter dried at 212° Fahr.	104·9	93·9
Nitrogen as nitrates - - -	0·950	1·076

* Prior to May 1899 bacterial action was not established in the tanks and consequently analyses prior to that time do not represent the purifying action of the bacteria. The figures marked * are the average of 47 analyses from May 1899 after bacterial action was set up.

(*b*) the best analysis of the final effluent and date when sample was taken; and

(*c*) the worst analysis of the final effluent and date when sample was taken;

Parts per 100,000.

	(*b*) Best sample 2 Mar. 1900.	(*c*) Worst sample 2 Mar. 1899.*
Ammonia - - - - -	0·045	12·50
Organic ammonia - -	0·015	0·85
Oxygen absorbed in three hours at 80° Fahr. - -	0·080	2·54
Chlorine as chlorides - -	3·40	16·30
Total solid matter dried in 212° Fahr. - - -	57·8	138·40
Nitrogen as nitrates - -	1·375	nil

* Bacterial action not established.

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;	30·0 parts per 100,000 by weight.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Not appreciable and not determined. Effluents always clear and colourless after bacterial action was fully established in May 1899.
(15) Give a typical analysis of the crude sewage to which the experiment relates.	Average of 37 Samples.

Free ammonia - - - - - -	10·35
Organic ammonia - - - - -	1·691
Oxygen absorbed in three hours at 80° Fahr.	5·030
Chlorine as chlorides - - - -	13·4
Total solid matter dried at 212° Fahr. -	144·2
Nitrogen as nitrates - - - - -	nil

(16) Between what dates was the experiment conducted?	February 1899 and February 1901.
If there were any periods of rest, state their duration.	None.
(17) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	None.
(18) Was any nuisance caused by the experimental works?	No.
(19) Is the experiment still proceeding? - - - -	Yes works still acting very satisfactorily.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.

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(20) Give particulars of any other observations of importance which were recorded.	1. Not affected by frost. 2. Night sewage and storm water can be dealt with. 3. Slight reduction in capacity of coarse tanks; none in fine tanks after two years. 4. Clinkers and coke breeze a good material for contact tanks; does not crumble. 5. No impairment of vital action of bacteria by keeping sewage in contact with material in coarse and fine contact tanks for 8 or 10 or even 12 hours. 6. Purifying action in coarse beds probably largely due to anaerobic organism. 7. Not less than four double contact tanks should be erected if the sewage is to be purified by that system.
(21) What inferences have been drawn from the experiment?	That a strong domestic sewage can be efficiently purified by double contact bacteria tanks, which can be erected at a moderate cost and maintained at a very small annual expense.
(22) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	About 5s. or less, but depends on district and cost of material.
(a) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers;	
(b) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

JOSEPH ROUTLEDGE,
Surveyer and Inspector.
Signature of Officer under whose direction the experiment was conducted.

16th March, 1901.

Form E.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS. (SINGLE CONTACT.)

Name of authority	Newbury (Borough).
Population of district	(about) 12,000.
Water supply per head of the population	18 to 20 gallons per day.
Estimated or measured dry weather flow of sewage	350,000 gallons per day, including subsoil water leakage into the sewers.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Yes, from four breweries; proportion is about 8 per cent. of flow of sewage exclusive of subsoil water.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Wholly excluded.
Officer under whom the experiment has been conducted	Borough Surveyor.
Name and qualification of chemist who has made the analyses.	James Brierley, Public Analyst, Southampton.

Note.—The experiments have been made on one class of bed only, no "roughing" or screening being necessary.

(1) (*a*) What was the water-holding capacity at commencement of experiment of the beds when filled with the filtering material?	Capacity of beds = 200 yards cube. 16,000 gallons.
(*b*) What was the depth of these beds?	4 ft.
(*c*) What were the nature and size of the filtering material?	Bed I., clinker; Beds II. and III., gravel — Lowest 1 ft. 6 in.—$2\frac{1}{2}$ in. gauge. Middle 1 ft. 6 in.—$1\frac{1}{2}$ in. " Top 1 ft. 0 in.— $\frac{3}{4}$ in. "
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	At end of month from filling of Bed I. capacity dropped to 11,000 gallons. At end of 12 months capacity dropped to about 8,500 gallons. The capacity of the two gravel beds has decreased in 9 months from 16,000 gallons to about 9,000 gallons.
(3) What was the water-holding capacity of the beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	Experiment still in progress. *See* answer to (2).
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	
(*c*) What was the nature and size of the filtering material?	
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(3) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Filled - 5 to 6 a.m. Standing full - 6 to 8 a.m. Emptied - 8 to 9 a.m. At rest - 9 to 11 a.m. Filled - 11 to 12 noon. Standing full - 12 to 2 p.m. Emptied - 2 to 3 p.m. At rest - 3 to 5 p.m. Filled - 5 to 6 p.m. Full - 6 to 8 p.m. Emptied - 8 to 9 p.m. At rest - 9 p.m. to 5 a.m.

Appendix 9C.

(7) State by what method the sewage was distributed on the beds.

By a level trough at both ends of each bed.

(8) What is the average quantity of sewage in gallons dealt with daily?

About 25,000 gallons per day on each bed (we have three).

(9) Was the quantity of sewage dealt with increased in time of storm?

Not appreciably.

If so, state to what extent, and how the results were affected by such increase.

- - -

(10) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper, or allowed to clear by standing before being analysed.

Only one set of analyses have been made, viz., of the clinker bed at end of 12 months' working, and of the gravel bed at end of 9 months' working.

(11) Give (*a*) the average of the analyses of the final effluent from the beds;

(*b*) the best analysis of the final effluent, and date when sample was taken; and

(*c*) the worst analysis of the final effluent, and date when sample was taken;

(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to the coarse bed;

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Analyses of two samples of effluent from Newbury, received 20th and 30th November, 1900:

Sample No. 1, from "clinkers," 19th November, 1900.

Physical characters:

Turbid, of deep reddish brown colour, black spot on white ground visible through 10 inches of effluent.

Chemical Analysis.

—	Parts per 100,000.	Grains per gallon.
Free ammonia - - -	3·8	2·66
Albuminoid ammonia - -	0·17	0·119
Nitrates - - - - -	Absent.	—
Chlorine as chloride - -	9·5	6·65
Equal sodium chloride -	15·65	10·955
Volatile solids - - -	24·0	16·8
Fixed solids - - -	42·0	29·4
Total solids - - - -	66·0	46·2

Oxygen absorbed in 15 minutes at 80° Fahr. 0·415 - 0·2905

Oxygen absorbed in 4 hours at 80° Fahr. 1·08 - - 0·765

Sample No. 2, from "gravel," 19th November, 1900.

Physical characters:

Turbid, deep yellowish red colour, black spot on white ground visible through 15 inches of effluent.

Chemical Analysis.

—	Parts per 100,000.	Grains per gallon.
Free ammonia - - -	4·3	3·01
Albuminoid ammonia - -	0·166	0·1162
Nitrogen as nitrates - -	0·05	0·035
Chlorine as chloride - -	8·0	5 6
Equal to sodium chloride -	13·18	9·22
Volatile solids - - -	25·0	17·5
Fixed solids - - -	44·0	30·8
Total solids - - - -	69·0	48·3

Oxygen absorbed in 15 minutes at 80° Fahr. 0·3751 0·2625

Oxygen absorbed in 4 hours at 80° Fahr. 0·9994 - 0·6995

Remarks.

Both samples have been thoroughly broken down, so far as their nitrogenous matters are concerned, and the nitrogen nearly all converted into free ammonia. Sample No. 2 is superior in clearness, colour, and oxidation to sample No. 1.

Both are well within the limits requred.

(12) Give a typical analysis of the crude sewage to which the experiment relates.

(13) Between what dates was the experiment conducted?

December, 1899, and present date.

If there were any periods of rest, state their duration.

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(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths	None made.
(15) Was any nuisance caused by the experimental works?	No.
(16) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Certainly.
(17) Give particulars of any other observations of importance which were recorded.	Our experiments have proved to us that *clean*, sifted shingly gravel is superior to clinker for contact beds. We are about to instal five extra beds of gravel, 5 ft. 6 in. deep, and hope, should we be favoured with a visit from your Commissioners, that these will be in working order for inspection. Not many analyses have been made, for the reason that the expense of this work has been considered prohibitive.
(18) What inferences have been drawn from the experiment?	*See* above.
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;	About 7*s*. to 10*s*. a head.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	About 6*d*. per head per annum.

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

S. J. L. Vincent.

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C

Form E

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS. (SINGLE CONTACT.)

Name of authority	Urban District Council of Newton-in-Makerfield, Lancs.
Population of district	(Estimated) 16,800.
Water supply per head of the population	15 gallons per day.
Estimated or measured dry weather flow of sewage	(Measured) 141,400 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Engineering works in district discharge blow-off from boilers, and some wagon-grease and oil from lubricating gets into the sewers. No breweries, no tanneries, no chemical works. Say 1 per cent. trade refuse.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially excluded.
Officer under whom the experiment has been conducted.	Arthur Bowes, A.M.Inst.C.E., Surveyor to the Council.
Name and qualification of chemist who has made the analyses.	J. Campbell Brown, D.Sc. (County Analyst.)

(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material? (*b*) What was the depth of these beds? (*c*) What was the nature and size of the filtering material? (2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not. (3) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	No coarse beds.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	Not measured. Capacity before filling: 105,470 gallons at No. 1 works; 131,250 „ „ No. 2 „
(*b*) What was the depth of these beds?	Three feet.
(*c*) What were the nature and size of the filtering material?	Screened hard clinker, and cinders. Bottom 18 inches; clinkers between 1 inch and 2 inch. Top 18 inches; cinders between $\frac{1}{4}$ inch and $\frac{1}{2}$ inch. All fine dust removed.
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	None.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	Not measured.
(6) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Usually 2 hours filling, always 2 hours full, 2 hours emptying, and 6 to 18 hours resting.
(7) State by what method the sewage was distributed on the beds.	Wooden troughs with V notches in sides.
(8) What was the average quantity of sewage in gallons dealt with daily?	50,223 gallons at one works (No. 1). 91,207 gallons at the other (No. 2).
(9) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	Increased to nearly three times normal.
(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	On two occasions only. *See* 11 and 12.

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(11) Give (*a*) the average of the analyses of the final effluent from the beds;

(*b*) the best analysis of the final effluent and date when sample was taken; and

10th July, 1900.

Total solids in solution - - -	74·8 per 100,000
„ „ in suspension - -	14·6 „
Ammonia - - - - - - -	3·47 „
Ammonia from organic matter - -	·42 „
Nitrogen as nitrates and nitrites -	·00 „
Combined chlorine - - - -	10·00 „
Oxygen absorbed in 3 minutes -	1·3 „
Oxygen absorbed in 4 hours - -	4·6 „

The percentage of solids removed mechanically from suspension is 90 per cent.

The percentage of improvement in ammoniacal matters is 80 per cent.

(*c*) the worst analysis of the final effluent and date when sample was taken;

(*c*) 22nd November 1900.

Total solids in solution - - -	71·40 per 100,000.
„ „ in suspension - -	18·00 „
Ammonia - - - - - -	2·37 „
Ammonia from organic matter -	5·95 „
Nitrogen as nitrates and nitrites -	·000 „
Combined chlorine - - -	8·200 „
Oxygen absorbed in 3 minutes -	·63 „
Oxygen absorbed in 4 hours - -	3·39 „

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed;

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

(12) Give a typical analysis of the crude sewage to which the experiment relates.

10th July 1900.

Total solids in solution - -	87·00 per 100,000
„ „ in suspension - -	153·000 „
Ammonia - - - - - -	4·28 „
Ammonia from organic matter -	2·06 „
Nitrogen as nitrates and nitrites -	·00 „
Combined chlorine - - -	14·50 „
Oxygen absorbed in 3 minutes -	4·28 „
Oxygen absorbed in 4 hours - -	21·80 „

(13) Between what dates was the experiment conducted? — 16th March 1900, to present time.

If there were any periods of rest, state their duration. — None.

(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths. — No observations taken.

(15) Was any nuisance caused by the experimental works? — None.

(16) Is the experiment still proceeding? - - - - — Yes.

If so, may the Commission inspect the works should they deem it desirable to do so? — Yes.

(17) Give particulars of any other observations of importance which were recorded.

(18) What inferences have been drawn from the experiment? — The inference that such a method of treating sewage is eminently suited to this district, but requires to include a preliminary settling or septic treatment, and most probably a secondary filtration in addition to the one referred to in these notes.

(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

ARTHUR BOWES, A.M. Inst. C.E.
Signature of officer under whose direction the experiment was conducted.

Appendix 9C. Form E.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS.

Name of authority	Eastry Rural District Council.
Population of district	1,000.
Water supply per head of the population	
Estimated or measured dry weather flow of sewage	24,000 gallons per day.
Is any trade refuse taken into the sewers?	Brewery waste; about 30 per cent.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Separate water supply not measured.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Drainage of back yards and roofs only admitted.
Officer under whom the experiment has been conducted	F. D. Anson, 15, Dean's Yard, Westminster, S.W.
Name and qualification of the chemist who has made the analyses	Sidney Harvey, F.I.C., Public Analyst, City and County of Canterbury.

(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	Two, holding 4,000 gallons each.
(*b*) What was the depth of these beds?	3 feet 6 inches.
(*c*) What was the nature and size of the filtering material?	Coke broken to a 2-inch gauge.
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No exact measurements were made of the liquid capacity of the beds, but it was found that after about 8 weeks' working, the capacity of the beds reached a constant quantity, from which they have not varied very much.
(3) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting	
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	
(*b*) What was the depth of these beds?	4 feet.
(*c*) What was the nature and size of the filtering material?	Second bed, coke broken to a ¾-inch gauge; third bed, a large cask filled with coke broken to a ¼-inch gauge.
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(6) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	(*a*) See (18). (*b*) 2 hours. (*c*) 1 hour. (*e*) See (18). 8 hours for the complete cycle on average.
(7) State by what method the settled sewage was distributed on the beds.	Allowed to flow on to the beds from distributing channels.
(8) What was the average quantity of sewage in gallons dealt with daily?	8,000 gallons.
(9) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No.

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(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.

Only three analyses were made :—
May 29th, 1899.
June 24th, 1899.
August 31st, 1899.

(11) Give (*a*) the average of the analyses of the final effluent from the beds.

AVERAGE OF THESE ANALYSES.

	No. 1 Crude Sewage.	No. 2 Effluent after 1st Treatment.	No. 3 Effluent after 2nd Treatment.	No. 4 Effluent after 3rd Treatment.
		Parts per 100,000	Parts per 100,000	Parts per 100,000
Appearance - - -	Dark Brown	—	—	—
Smell - - - - -	Very offensive	—	—	—
Suspended matter (organic)	106·5	10·71	8·55	2·14
Suspended matter (mineral)	37·1	3·24	2·28	1·96
Suspended matter (total)	143·6	18·95	10.83	4·10
Matter in solution	154·84	146·11	134·12	135·94
Combined chlorine	11·00	14·09	15·24	16·17
Nitrogen as nitrates	·46	·19	·21	·74
ammonia- - - -	3·10	2·67	1·51	·58
Albuminoid ammonia	1·55	·37	·20	·14
Oxygen absorbed in 4 hours.	12·32	5·05	3·54	1·72

(*b*) the best analysis of the final effluent and date when sample was taken, and

24th June, 1899 :—

Appearance - - - - - - -	Colourless
Smell - - - - - - - -	None
Suspended matter, organic - - -	·22
„ „ mineral - - -	·43
„ „ total - - -	·65
Matter in solution - - - -	121·91
Combined chlorine - - - -	15·48
Nitrogen as nitrites - - - -	1·87
Ammonia - - - - - -	1·27
Albuminoid ammonia - - - -	·09
Oxygen absorbed in 4 hours- - -	1·00

(*c*) the worst analysis of the final effluent and date when sample was taken.

31st August, 1899.

Appearance - - - - - - -	Slight
Smell - - - - - - - -	—
Suspended matter, organic - - -	3·06
„ „ mineral - - -	3·54
„ „ total - - -	6·60
Matter in solution - - - -	156·60
Combined chlorine - - - -	21·77
Nitrogen as nitrites - - - -	2·61
Ammonia - - - - - -	1·77
Albuminoid ammonia - - - -	·12
Oxygen absorbed in 4 hours- - -	1·40

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Apparently not putrescible.

(12) Give a typical analysis of the crude sewage to which the experiment relates.

Two samples :—

	July 23rd, 1898.	24th May, 1899.
	Parts per 100,000.	Parts per 100,000.
Appearance - - - - -	Very turbid and floculent	Deep brown colour.
Smell - - - - - -	Very offensive.	Very offensive.
Reaction - - - - -	Acid.	
Suspended matter, organic -	25·09	262·4
„ „ mineral -	3·27	79·2
„ „ total -	28·36	341·6
Matter in solution - -	104·30	246·1
Including chlorine - -	9.30	12·8
Ammonia - - - - -	2·70	3·3
Albuminoid Ammonia - -	·90	3·3
Oxygen absorbed - -	8·80	19·7

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(13) Between what dates was the experiment conducted?	March, 1899, present time.
If there were any periods of rest, state their duration.	
(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	
(15) Was any nuisance caused by the experimental works?	No complaint has come to my knowledge.
(16) Is the experiment still proceeding?	The beds are still being worked regularly.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(17) Give particulars of any other observations of importance which were recorded.	
(18) What inferences have been drawn from the experiment?	The sewage was allowed to flow direct into the first bed from the sewer, and the time of filling them consequently varied considerably, often occupying six or seven hours, while at other times they were filled in little over an hour. The result of this was that septic action was set up in these beds and they became inefficient. That in this case it is necessary to have some sort of receiving tank by means of which the flow on to the bed may be regulated, and the quality of the sewage made more uniform. The Council are now applying for a loan to enable them to construct works to deal with the whole of the sewage, by first passing it through a scum tank and afterwards into contact beds. This tank will also be used as a collecting tank from which the effluent will be discharged periodically.
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	£2 10s.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	Part of attendant's wages and interest on capital and occasional renewal of filtering material.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no "Septic" action is produced.

Signature of Officer under whose direction the experiment was conducted.

Form E.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority	Hampton Urban District Council.
Population of district	7,000 (4,600 at present connected to sewage system).
Water supply per head of the population	No exact information, but as the dry-weather flow of sewage is at the rate of 22½ gallons per head, it is no doubt somewhat approximate thereto.
Estimated or measured dry weather flow of sewage	107,500 gallons per day, which includes 4,000 gallons of flushing water.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	No, with the exception of that arising from slaughter-houses.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Wholly excluded.
Officer under whom the experiment has been conducted.	John Kemp, Assoc.M.Inst.C.E., Surveyor.
Name and qualification of chemist who has made the analyses.	Charles E. Cassall, F.I.C., Public Analyst for Kensington, St. George's Hanover Square, Battersea, and the administrative counties of Kesteven and Holland, Lincolnshire.

(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	20,000 gallons each bed. (The beds are five in number.)
(*b*) What was the depth of these beds?	4 feet.
(*c*) What were the nature and size of the filtering material?	Furnace refuse rejected by a ¾-in. mesh sieve. Anything above this size was used. Some pieces as large as 12 in. diameter.
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	Two of the coarse beds were measured in October 1900, after one year and 10 months working, and were found to have retained their original liquid capacity. One of the coarse beds was again tested at the beginning of February 1901, after nearly two years and three months working, and still found to maintain its original liquid capacity.
(3) What was the water-holding capacity of the coarse beds at end of experiment?	As stated above.
If the measurement was made after resting, please give the duration of the resting.	Measurements taken in actual working. No rest given.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	This was not taken, but it was equal at least to that of the coarse beds.
(*b*) What was the depth of these beds?	4 feet.
(*c*) What were the nature and size of the filtering material?	Furnace refuse passed through a ¾-in. sieve, and rejected by a ¼ inch sieve.
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	None have been made.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	See above.
( ) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Two beds are filled once in 24 hours. " " " twice " " One bed always resting. (*a*) ¾ to 1 hour, (*b*) 2 hours, (*c*) 1 hour, (*e*) not less than 2 hours but varies considerably, as quantity of sewage not yet equal to full working capacity of beds.
(7) State by what method the sewage was distributed on the beds.	In shallow wooden troughs for 2 beds, for the remaining 3 beds the sewage runs direct on to the beds without any special means of distribution.
(8) What was the average quantity of sewage in gallons dealt with daily?	This has been a growing quantity from the first connection made to the sewers on the 8th Dec. 1898, until now, when the quantity is 107,500 gallons.

Appendix 9C.

(9) Was the quantity of sewage dealt with increased in time of storm?	Very slightly.
If so, state to what extent, and how the results were affected by such increase.	Not affected in any way.
(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Only one analysis has been made, this was on the 10th October 1899.
(11) Give (*a*) the average of the analyses of the final effluent from the beds.	Appearance in porcelain vessel 1 in. deep - Clean and bright; colourless. Appearance in 1-ft. vessel - Clean and bright: slightly greenish yellow tint. Odour - - - - - None. Reaction - - - - - Neutral. Total solid matters - - - 106·4 parts per 100,000. Chlorine as chlorides - - 18·5 „ „ Nitrogen as nitrates - - 2·52 „ „ Oxygen absorbed from permanganate, 30 deg., 4 hours. 4·00 parts per 1,000,000. Saline ammonia - - - 0·968 „ „ Organic ammonia - - - 0·448 „ „ Appearance of solids on ignition. Marked blackening. Nitrates - - - - - Marked traces.
(*b*) the best analysis of the final effluent and date when sample was taken, and (*c*) the worst analysis of the final effluent and date when sample was taken	Only one taken.
(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to the coarse bed.	Mr. Cassall states that the "raw sewage contained a large quantity of suspended matter."
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Only one made, the analyst stating that the effluent was entirely free from suspended matter, and devoid of offensive odour. After passing through land the effluent contained 4·8 parts per 100,000 of suspended matter.
(12) Give a typical analysis of the crude sewage to which the experiment relates.	Appearance in porcelain vessel 1 in. deep. Opaque and thick; strong sewage colour. Appearance in 1-foot tube - Ditto. Ditto. Odours - - - - - Very offensive. Reaction - - - - Faintly alkaline. Total solid matters - - - 278·4 per 100,000. Chlorine as chlorides - - 89·0 „ „ Nitrogen as nitrates - - 0·0 „ „ Oxygen absorbed from permanganate, 30 deg. C., 4 hours. 129·4 „ 1,000,000. Saline ammonia - - - 79·32 „ „ Organic - - - - - 15·2 „ „ Appearance of solids on ignition. Intense blackening (inflammable residue). Nitrates - - - - - Absent.
(13) Between what dates was the experiment conducted?	From Dec. 8th, 1898, and is still going on.
If there were any periods of rest, state their duration.	Each coarse bed rests one week out of five.
(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths	None have been made.
(15) Was any nuisance caused by the experimental works?	No.
(16) Is the experiment still proceeding? - - -	Yes.
If so, may the Commission inspect the works should they deem it desirable to do so?	Yes.
(17) Give particulars of any other observations of importance which were recorded.	Two of the coarse beds have a top layer of very large-sized rough clinker, and it is remarkable that the tops of the beds have only been disturbed twice in 12 months for cleansing. It has also been observed that if the growth of vegetables, which commences on these two beds in the early spring, be left undisturbed until autumn, and then pulled and cleared away, the top and body of the beds are perfectly clean, the paper and all solid matter having disappeared. It is found that the final effluent from the final contact is an excellent water for the boilers, leaving practically no incrustation or corrosion on the boiler. None but this water is used for condensing, cooling, and feed purposes.

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(18) What inferences have been drawn from the experiment?	In the first place, it should be stated that the treatment of the whole of the sewage of Hampton on bacteriological lines has not been regarded purely as an experiment, the Council and its advisers having previously visited various experimental works, and come to the conclusion that it was quite possible to treat the whole of the sewage of the district bacteriologically, and really the results have exceeded our expectations, more particularly as regards the liquid capacity of the coarse beds, which is fully maintained after two years working. The installation is easily worked and managed at a small cost as compared with chemical treatment. There is no doubt whatever that the whole of the sewage of any town, and of a purely domestic character, where the separate system in its entirety is adopted, could be similarly treated. It may here be stated that the effluent is constantly being analysed by the Thames Conservancy, by whom it is termed "a good effluent."
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers,	Actual cost at Hampton = 7*s.* 4*d.*
(*b*) What would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	Actual cost at Hampton, 5*d.*

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

JOHN KEMP

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form E.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority	Huddersfield Corporation.
Population of district	105,000.
Water supply per head of the population	Domestic purposes 14 gallons per day, trade purposes nine gallons per day.
Estimated or measured dry weather flow of sewage	Measured 7,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes, a large quantity, chiefly from the scouring, dyeing and finishing of wool, &c.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	29 per cent. of dry weather flow.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted	Borough Engineer.
Name and qualification of chemist who has made the analyses.	Percy Coward.

(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	The initial capacity of the coarse bed was 19,000 gallons.
(*b*) What was the depth of these beds?	3 ft. 6 in.
(*c*) What were the nature and size of the filtering material?	Ordinary furnace clinker and coke. Half inch to about four inches.
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	See table below.

Date.	Capacity.	Previous rest.
1898. August 9th	19,000	Initial capacity.
1899. March 3rd	9,000	2 hours.
" May 31st	7,300	2 "
" July 11th	6,100	2 "
" October 17th	5,600	2 "
1900. January 24th	4,800	2 "

(3) What was the water-holding capacity of the coarse beds at end of experiment?	4,800 gallons after resting.
If the measurement was made after resting, please give the duration of the resting.	Two hours.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	19,000 gallons (approx.).
(*b*) What was the depth of these beds?	3 ft. 3 in.
(*c*) What were the nature and size of the filtering material?	Top 9 in. clinker ¼-in. to ⅝-in., 1 ft. 11 in. clinker ¼-in. to 1½-in.; bottom 7 in. clinker large pieces.
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	At the commencement of the experiment the contents of the coarse bed about filled the fine beds.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	At the finish less than a third of the fine bed was filled by the contents of the coarse bed.

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(6) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Filled twice a day,

—	Coarse.	Fine.
(*a*) - - - - -	2 hours.	2 hours.
(*b*) - - - - -	4 ,,	4 ,,
(*c*) - - - - -	2 ,,	3 ,,
(*e*) - - - - -	16 ,,	15 ,,

(7) State by what method the sewage was distributed on the beds.	Troughs.
(8) What was the average quantity of sewage in gallons dealt with daily?	16,390 gallons per day.
(9) Was the quantity of sewage dealt with increased in time of storm?	No.
If so, state to what extent, and how the results were effected by such increase.	No.
(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Samples were analysed daily. Neither filtered through paper nor allowed to clear by standing.

(11) Give (*a*) the average of the analyses of the final effluent from the beds.

Nitrous and nitric nitrogen - - -	·171	(15 weeks).
Ammoniacal nitrogen - - - -	·30	(76 weeks).
Albuminoid nitrogen - - - -	·108	,,
Oxygen absorbed in four hours at 80° F.	2·04	,,
,, ,, in three minutes -	·69	,,

(*b*) the best analysis of the final effluent and date when sample was taken, and

Sept. 30th 1899.	
Ammoniacal nitrogen - - - -	·035
Albuminoid nitrogen - - - - -	·020
Oxygen absorbed in four hours at 80° F. -	·77
,, ,, in three minutes - -	·23

(*c*) the worst analysis of the final effluent and date when sample was taken.

Sept. 14th 1898.	
Ammoniacal nitrogen - - - -	·55
Albuminoid nitrogen - - - - -	·215
Oxygen absorbed in four hours at 80° F. -	4·34
,, ,, in three minutes - -	1·81

(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to to the coarse bed.	Not estimated.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Traces, not estimated. The effluent when kept for seven days at 80° Fah. in a stoppered bottle (completely filled) frequently became putrescent.

(12) Give a typical analysis of the crude sewage to which the experiment relates.

Albuminoid nitrogen - - - - - - -	·608
Total organic nitrogen - - - - - -	1·23
Ammoniacal nitrogen - - - - - - -	1·24
Nitrous and nitric nitrogen - - - -	·02
Oxygen absorbed in four hours at 80° F.:	
Sample shaken - - - - - - -	9·71
,, settled - - - - - - -	7·69
,, filtered - - - - - - -	5·31
Chlorine - - - - - - - - -	14·1
Reaction. Slightly alkaline to litmus.	

Solids.

In suspension—	
Mineral - - - - - - - -	16·4
Volatile - - - - - - - -	18·2
Total	34·6
In solution—	
Mineral - - - - - - - -	59·7
Volatile - - - - - - - -	11·8
Total	71·5

Total Solids.

Mineral - - - - - - - - -	76·1
Volatile - - - - - - - - -	30·0
Total	106·1

(13) Between what dates was the experiment conducted?	August 1898 to February 1900.
If there were any periods of rest, state their duration.	Sundays. Also one week in January, 1899, and one week in September, 1899.
(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	None made.
(15) Was any nuisance caused by the experimental works?	No.

Appendix 9C

(16) Is the experiment still proceeding? If so, may the Commission inspect the works, should they deem it desirable to do so?	Discontinued.
(17) Give particulars of any other observations of importance which were recorded.	Samples of deposit were taken from different parts of the coarse beds at various times, and the proportion of organic to mineral matter contained in them determined. The results obtained are as follows :—

—	Dried at 212° F.	
	Mineral per cent.	Organic per cent.
Average sample of deposit from :—		
Near troughs from surface to 12 in. down the bed, taken after heavy rains in February 1899 - -	93·8	6·2
Near troughs (within 18 in.) from surface to 18 in. down the bed taken after dry weather, October 1899 - - - - - - -	73·5	26·5
Peeled off clinker from 6 in. to 30 in. down the bed, but not within 18 in. of troughs, October 1899 - - - - - - -	64·2	35·8
Peeled off the surface of the bed, but not within 18 in. of the troughs, October 1899 - -	44·1	55·9
Taken off clinker within 24 in. of the bottom, when the bed was being taken out, March 1900 -	63·7	36·3

(18) What inferences have been drawn from the experiment?	That it would be possible to purify by triple contact the crude sewage of Huddersfield. That the rapid deposition of irreducible matter in the coarse beds would necessitate their renewal being of so frequent occurrence as to render it a far too costly scheme to be adopted.
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	No.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	£1 3*s*. 7*d*.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

J. G. L. Campbell, M.Inst.C.E.

Signature of Officer under whose direction the experiment was conducted.

Form E.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS.

Northern Outfall. Small experimental beds fed with unscreened and unsettled raw sewage.

Name of authority	London County Council.
Population of district: (Sewage derived from London north of Thames.)	3, 251,974 (1896).
Water supply per head of the population	34·8 gallons per day (1900).
Estimated or measured dry weather flow of sewage	123,000,000 gallons per day (1900).
Is any trade refuse taken into the sewers?	Trade refuse from districts drained is taken into the sewers.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Quantity not known.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted	Professor Clowes, D.Sc.
Name and qualification of chemist who has made the analyses.	Mr. E. B. Pike.

(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?

Primary coarse bed A:—68·7 per cent.
Primary coarse bed B:—70·3 per cent. of tank capacity without coke. (Measurement made with the coke dry.)

(*b*) What was the depth of these beds?

9 ft. 9 in.

(*c*) What were the nature and size of the filtering material?

Coke passed through a 2-in. mesh and rejected by a ½-in. mesh.

(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.

Date.	Primary coarse bed **A.**	Primary coarse bed B.
1899, 20th Sep. (After 2½ months' work.)	41·9	33·3
1899, 27th Oct.	32·3	32·7
„ 6th Dec.	31·3	27·6
1900, 4th Jan.	26·8	24·7
„ 7th Feb.	21·8	22·2

(3) What was the water-holding capacity of the coarse beds at end of experiment.

Last measurements as above.

If the measurement was made after resting, please give the duration of the resting.

Measurement made after 17 hours resting empty.

(4) (*a*) What was the water-holding capacity at commencement of experiment of the secondary beds when filled with the filtering material?

Secondary coarse bed A:—61·7 per cent.
Secondary fine bed B:—53·1 per cent. (Measurement made with the coke dry.)

(*b*) What was the depth of these beds?

9 ft. 9 in.

(*c*) What were the nature and size of the filtering material?

Coke. Course bed A.—Passed through a 2-in. mesh and rejected by ½-in. mesh.
Fine bed B.—Passed through a ½-in. mesh and rejected by a $\frac{1}{16}$-in. mesh.

(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the secondary beds, stating in each case whether measurement was made after resting or not.

Date.	Secondary coarse bed A.	Secondary fine bed B.
1899, 20th Sept.	56·8	48·1
„ 27th Oct.	54·9	46·9
„ 6th Dec.	53·1	48·1
1900, 4th Jan.	50·6	47·0
„ 7th Feb.	50·6	44·4

(*b*) What was the water-holding capacity of secondary beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.

Last measurements as above. Measurements were made after 17 hours resting empty.

Appendix 9C.

(6) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods, of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Once a day from 4th July, 1899, to 9th Dec., 1899 (both inclusive). Twice a day from 11th Dec., 1899, to 30th Dec., 1899. (*a*) 45 minutes. (*b*) 2 hours. (*c*) 1 hour. (*e*) 20 hours for one filling daily. 8 hours for two fillings daily.
(7) State by what method the sewage was distributed on the beds.	Splashed on a board laid on the surface of the bed.
(8) What was the average quantity of sewage in gallons dealt with daily?	*About* 290 gallons per filling in each series A and B.
(9) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No.
(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Daily averages. Filtered except in the case of the estimations of oxygen absorbed by the total putrescible matter.

(11) Give (*a*) the average of the analyses of the final effluent from the beds

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken

	Secondary coarse bed A.	Secondary fine bed A.
Oxygen absorbed from permanganate in four hours at 80° F.	2·309	1·467
Nitrous nitrogen - -	0·1096	0·0584
Nitric nitrogen - -	1·3256	2·2659
	4 Sept., 1899:	26 July, 1899
(*b*) Oxygen absorbed in four hours at 80° F.	1·053	0·626
Nitric nitrogen - -	3·4714	1·7549
	16 Aug., 1899:	21 Dec., 1899:
(*c*) Oxygen absorbed in four hours at 80° F.	4·000	3·857
Nitric nitrogen - -	2·510	0·3647

(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to the coarse bed.	49 parts per 100,000.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Not estimated. Non-putrescible.
(12) Give a typical analysis of the crude sewage to which the experiment relates.	Oxygen absorbed in 4 hours at 80° F. - 6·163 Nitrous nitrogen - - - - - - 0·0057 Nitric „ - - - - - - 0·1331
(13) Between what dates was the experiment conducted?	4th July, 1899, to 19th May, 1900.
If there were any periods of rest, state their duration.	On Sundays, four consecutive days in August, 1899; five consecutive days at Christmas; and during 1900 on Jan. 4, 18; Feb. 3, 7, 19, 20; Mar. 15, 17; April 12, 13, 14, 16, 17, 28; May 7, 8.
(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	In Series A. the interior of the primary bed, 4 hours after emptying, was 50·5° F. (=the temperature of the sewage supplied to the bed); the air outside was standing at 42° F. The interior of the secondary bed, four hours after emptying, was 48° F. (or 2° higher than the liquid from the primary bed, with which it had been filled); the temperature of the air outside was 41° F.
(15) Was any nuisance caused by the experimental works?	No.
(16) Is the experiment still proceeding?	No.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(17) Give particulars of any other observations of importance which were recorded.	

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(18) What inferences have been drawn from the experiment?	It was proved that the primary beds rapidly and continuously decreased in capacity when they were fed with unscreened and unsedimented raw sewage. The secondary beds, however, suffered no such diminution in capacity.
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(a) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers?	
(b) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan?	

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen

FRANK CLOWES,

Signature of officer under whose direction the experiment was conducted.

Chief Chemist to the London County Council.

Appendix 9C Form E.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS.

Southern Outfall The 13-foot Coke Bed dealing with crude and settled sewage.

Name of Authority :	London County Council.
Population of District : (Sewage derived from London, South of Thames)	1,678,104 (1896).
Water Supply per head of the population.	34·8 gallons per day (1900).
Estimated or measured dry weather flow of sewage.	About 90,000,000 gallons per day (1900).
Is any trade refuse taken into the sewers?	Trade refuse is taken into the sewers.
If so, state from what process it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Quantity is not known.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted?	Professor Clowes, D.Sc.
Name and qualification of Chemist who has made the analyses	Mr. J. W. H. Biggs.
(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	51 per cent. of the empty tank calculated when the coke was wet.
(*b*) What was the depth of these beds?	13 feet (similar results were obtained by 4 feet and 6 feet beds).
(*c*) What were the nature and size of the filtering material?	Coke, which passed through a 2-inch mesh, and which was rejected by a 1-inch mesh.
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	1899. April 11 - - - - - 7,900 June 8 - - - - - 6,670 Oct. 10 - - - - - 5,530 1900. Jan. 12 6,000. Rested from Dec. 22, 1899. June 16 6,000. Rested from April 5 to May 2.
(3) What was the water-holding capacity of the coarse beds at end of experiment?	Oct. 8, 1900, 6290. (Calculated on the capacity of the lower 6 feet of the bed.
If the measurement was made after resting, please give the duration of the resting.	From July 28, 1900, to Oct. 8, 1900.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	No fine beds were used.
(*b*) What was the depth of these beds?	
(*c*) What were the nature and size of the filtering material?	
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	The history of the fine bed may be divided into three periods (*a*, *b*, and *c*). (*a*) The bed received *crude* sewage between February 27 and October 10, and was filled generally twice a day. Its capacity diminished rapidly, as is shown by the following figures:—March 9, 1899, capacity 7,900 gallons. June 8, 1899, capacity 6,670 gallons. (*b*) The bed received very roughly sedimented sewage between October 10 and April 5, and was filled twice a day to December 22, and three times a day to April 5. The capacity on January 12, 1900, was 6,000 gallons. (*c*) The bed received settled sewage between May 2 and July 28, 1900, and was filled four times a day. Its capacity on June 16, 1900, was 6,000 gallons. In October 8 was 6,290 gallons (calculated).
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting?	

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(6) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Number of fillings varied between one and four per day of 24 hours:— (*a*) $\frac{1}{2}$ to $\frac{3}{4}$ hour. (*b*) 2 hours. (*c*) 1 hour. (*e*) Variable. With one or two fillings per day, the bed rested throughout the night. With three or four fillings, the bed was worked during the night, and therefore rested $4\frac{1}{4}$ to $4\frac{1}{2}$ hours, or $2\frac{1}{4}$ to $2\frac{1}{2}$ hours.
(7) State by what method the sewage was distributed on the beds.	Splashing on to perforated wooden trays.
(8) What was the average quantity of sewage in gallons dealt with daily?	7,000 to 25,000.
(9) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No.
(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Daily. Filtered through filter paper except in the case of the estimations of total putrescible matter as measured by the oxygen absorbed from permanganate.
(11) Give (*a*) the average of the analyses of the final effluent from the beds.	Oxygen absorbed from permanganate in four hours at 80° F.: By the total putrescible matter - - - - 3·749 By the dissolved putrescible matter - - - 2·556 Nitrous nitrogen - - - - - - - - 0·038 Nitric nitrogen - - - - - - - - 0·158 Throughout the experiment the average purification effected as judged by the oxygen absorbed from permanganate in four hours at 80° F. by the dissolved matter was 52·1 per cent.
(*b*) the best analysis of the final effluent and date when sample was taken, and	July 4, 1899.
(*c*) the worst analysis of the final effluent and date when sample was taken.	December 22, 1899. Oxygen absorbed from permanganate in four hours at 80° F.: (*b*) (*c*) By the dissolved putrescible matter 0·732 4·906 Nitrous nitrogen - - - - - Trace None Nitric nitrogen - - - - - 0·114 Trace (*c*) In this case the corresponding sewage was exceptionally bad.
(*d*) the average of the estimations made of the solids in suspension in the crude sewage as it went on to the coarse bed.	40 parts per 100,000.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Too small in amount to be estimated. Not putrescible.
(12) Give a typical analysis of the crude sewage to which the experiment relates.	Suspended solids - - - - - - - 40 Dissolved solids - - - - - - - 110 Oxygen absorbed from permanganate in four hours at 80° F.:— By the total putrescible matter - - - 8·000 By the dissolved putrescible matter - - 5·500 Nitrous nitrogen - - - - - - - None Nitric nitrogen - - - - - - - None Albuminoid nitrogen - - - - - - 0·350
(13) Between what dates was the experiment conducted?	Feb. 27, 1899, and July 28, 1900. Bed was filled 657 times.
If there were any periods of rest, state their duration	Periods of rest:— 1899.—March 9. March 30 to April 3. May 20 to 23. June 10 to 18. July 8, 9, 13, 16, 22 to 24, 26 to 30. August 5 to 8, 17 to 20. September 8, 30. October 10 to 12, 14, 15, 17 to 22. October 24 to November 6. November 13. December 11, 22 to January 12, 1900 1900.—April 5 to May 2. (All dates inclusive.)
(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	No observations made

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(15) Was any nuisance caused by the experimental works?	No.
(16) Is the experiment still proceeding? - - - -	No.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(17) Give particulars of any other observations of importance which were recorded.	
(18) What inferences have been drawn from the experiment?	That the crude sewage cannot be dealt with without being subjected to a preliminary settling process, as the beds receiving crude sewage choke up rapidly. That where the sewage has been well settled to get rid of the greater portion of suspended solids, a bed will continue to work well without appreciable loss of capacity.
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Frank Clowes.

Signature of Officer under whose direction the experiment was conducted.

Chief Chemist to the London County Council.

Form E.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN CONTACT BEDS.

Northern Outfall.—Small experimental beds. Kentish Ragstone, as a neutralising material, was tried comparison with coke.

Name of authority	London County Council.
Population of district (Sewage derived from London North of Thames).	3,251,974 (1896).
Water supply per head of the population	34·8 gallons per day 1900).
Estimated or measured dry weather flow of sewage	123,000,000 gallons per day (1900).
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Trade refuse from districts drained was taken into the sewers. Quantity not known.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted.	Professor Clowes, D.Sc.
Name and qualification of Chemist who has made the analyses.	Mr. E. B. Pike.
(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	Ragstone bed, 40 per cent.; Coke bed, 50 per cent. of empty tanks without material measurements taken after one week's work.
(*b*) What was the depth of these beds?	5 feet.
(*c*) What were the nature and size of the filtering material?	One bed of Kentish Ragstone; one bed of Coke. Both materials were of such a size as to pass a 4-inch mesh and be rejected by a ½-inch mesh.
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	Ragstone bed 36·6 per cent.; Coke bed 39·0 per cent., measured after 16 weeks' work. Raystone bed 34·8 per cent., Coke bed 33·6 per cent.; measured after 24 weeks' work. The beds had not rested, as the capacities were measured by the quantities of effluent which ran from the bed. The drainings were not included.
(3) What was the water-holding capacity of the coarse beds at end of experiment?	Not estimated.
If the measurement was made after resting, please give the duration of the resting.	The beds were at work for 5 weeks after the last capacity measurements, as shown above, were taken.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	Not estimated.
(*b*) What was the depth of these beds?	5 feet.
(*c*) What were the nature and size of the filtering material?	Ragstone which passed through ½-inch mesh, and which was rejected by a $\frac{1}{16}$ inch mesh. Coke of the same size.
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	Capacities not taken.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting	
(6) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting	Beds were filled once a day from September 22, 1898, to January 9, 1899 (inclusive), and twice a day from January 11, 1899, to April 15, 1899, (*a*) about 10 minutes, (*b*) 2 hours, (*c*) ½ hour, (*e*) 9 or 18 hours (1 or 2 fillings).
(7) State by what method the sewage is distributed on the beds	The beds were 4 feet square, and the sewage fell from the pipe on to a board 1 foot square, which rested on the surface of the bed.
(8) What was the average quantity of sewage in gallons dealt with daily?	Ragstone beds, 240 gallons; Coke beds, 275 gallons.

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(9) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase	No.
(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed	Daily Averages.—Samples were filtered through filter paper.
(11) Give (*a*) the average of the analyses of the final effluent from the beds.	Oxygen absorbed from permanganate in 4 hours at 80° F.: (*a*) Ragstone bed, 2·761. Coke bed, 1·994.
(*b*) the best analysis of the final effluent and date when sample was taken, and	Ragstone Bed: (*b*) Jan. 16, 1899 - 1·429. Coke Bed: Oct. 5, 1898 - - 0·714.
(*c*) the worst analysis of the final effluent and date when sample was taken.	Ragstone Bed: (*c*) Dec. 1, 1898 - 4·000. Coke Bed: Dec. 7, 1898 - - 3·143
(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to the coarse bed.	Crude unsettled sewage was supplied to the beds. 49 parts per 100,000.
(*e*) the average of the estimations made of the solids in suspension in the final effluent Were these putrescible?	Not estimated. Not putrescible.
(12) Give a typical analysis of the crude sewage to which the experiment relates.	Oxygen absorbed from permanganate in 4 hours at 80° F.: Average throughout the experiment, 5·424.
(13) Between what dates was the experiment conducted?	September 22, 1898, and April 15, 1899.
If there were any periods of rest, state their duration.	Sundays, 4 days at Christmas, and 2 days occasionally for boiler cleaning.
(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	
(15) Was any nuisance caused by the experimental works?	
(16) Is the experiment still proceeding? If so, may the Commission inspect the works, should they deem it desirable to do so?	No.
(17) Give particulars of any other observations of importance which were recorded.	
(18) What inferences have been drawn from the experiment?	It was inferred that no advantage resulted from using ragstone containing calcium carbonate—a neutralising substance—in place of coke; it had been surmised that the presence of calcium carbonate might promote bacterial action.
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

FRANK CLOWES,

Signature of Officer under whose direction the experiment was conducted.

Chief Chemist to the London County Council.

Form E.

Appendix 9

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority	Maidstone.
Population of district	35,000 (estimated).
Water supply per head of the population	16½ gallons per day.
Estimated or measured dry weather flow of sewage	1,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes. Brewery, paper mill, tan-yard and slaughterhouse are the principal.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Storm water is excluded from the sewers in about half of our drainage area.
Officer under whom the experiment has been conducted	The Borough Surveyor.
Name and qualification of chemist who has made the analyses.	Dibdin and Thudichum.
(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering materal?	12,000 gallons.
(*b*) What was the depth of these beds?	3 ft. 4 in.
(*c*) What were the nature and size of the filtering material?	Furnace clinkers rejected by ⅜ in. mesh sieve.
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	
(3) What was the water-holding capacity of the coarse beds at end of experiment?	
If the measurement was made after resting, please give the duration of the resting.	
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	14,000 gallons.
(*b*) What was the depth of these beds?	4 ft. 4 in.
(*c*) What were the nature and size of the filtering material?	Furnace clinkers passed through ½ inch mesh sieve, and with firedust afterwards removed.
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(6) State method of working of contact beds, *i.e.*, number of fillings per day of 24 hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Once and twice per day. (*a*) 40 minutes. (*b*) 2 hours at first, afterwards 1½ and 1 hour. (*c*) 1½ hours. (*e*) 2 hours and 1 day in 7.
(7) State by what method the sewage was distributed on the beds.	At first by means of open distributing channels. These were afterwards removed, and the effluent appeared equally good.
(8) What was the average quantity of sewage in gallons dealt with daily?	12,000 at each filling.
(9) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	Sewage with a large proportion of storm water has been dealt with on the beds, but the beds are filled by means of a pump, and consequently the quantity dealt with has been always the same.
(10) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper, or allowed to clear by standing before being analysed.	April and May 1899. By standing.

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(11) Give (*a*) the average of the analyses of the final effluent from the beds.

Cl., 8·7 parts per 100,000.
Ammoniacal nitrogen, 2·13 parts per 100,000.
Albuminoid nitrogen, 0·23 parts per 100,000.
Oxygen absorbed, 4 hours, 3·20 parts per 100,000.
Suspended matters, traces.

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken.

Chlorine.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Oxygen Absorbed.	Suspended matter.
8·7	0·72	0·165	3·20	Trace, April 6, 1899.
9·1	2·73	·220	3·84	Trace, May 8, 1899.

(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to coarse bed.

81·0 parts per 100,000.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Trace. No.

(12) Give a typical analysis of the crude sewage to which the experiment relates.

Cl., 9·0 parts per 100,000.
Ammoniacal nitrogen, 4·95 parts per 100,000.
Albuminoid nitrogen, 0·747 parts per 100,000.
Oxygen, in 4 hours, 11·15 parts per 100,000.
Suspended matter, 81·00 parts per 100,000.

(13) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.

Beds first filled Oct. 1898, and continued ever since. The beds have been rested at intervals when we have been occupied with other work, but on no occasion for more than about seven days.

(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

None made.

(15) Was any nuisance caused by the experimental works?

Absolutely none. No smell has ever been noticed on the beds.

(16) Is the experiment still proceeding?

Yes.

If so, may the Commission inspect the works, should they deem it desirable to do so?

Yes.

(17) Give particulars of any other observations of importance which were recorded.

The coarse bed was dug down to the floor of the tank after 18 months work, and no deposit was noticeable on the bottom, the clinkers were practically as clear as ever up to within 8 in. to 9 in. of the surface, and this was of a spongy nature, but having the odour of fresh garden soil.

(18) What inferences have been drawn from the experiment?

That the sewage of Maidstone is amenable to bacterial treatment.

(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

Yes.

(*a*) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.

25*s*.

(*b*) What would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.

8*d*.

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen.
Nitric nitrogen,
Total organic nitrogen.

J. Bunting.

Signature of Officer under whose direction the experiment was conducted.

Form E. Appendix 9C.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS.

Bed A (primary) in conjunction with Bed B (secondary).

Name of authority	Manchester.
Population of district	516,000.
Water supply per head of the population	28 gallons per day.
Estimated or measured dry weather flow of sewage	21,000,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Yes.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enters the sewers.
Officer under whom the experiment has been conducted.	Gilbert J. Fowler, M.Sc. (Vict.), F.I.C.
Name and qualification of chemist who has made the analyses.	W. Clifford, A.R.C.Sc.I. H. D. Bell, E. Hadfield, A. C. Oddie } Junior Assistants. Under the direction of G. J. Fowler.

(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse bed when filled with the filtering material?

4,530.

(*b*) What was the depth of this bed?

3 feet.

(*c*) What was the nature and size of the filtering material?

Screened clinker. Rough material round the drain pipes. Material uniform throughout the bed. Passed 3-inch mesh, rejected by 1-inch mesh.

(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.

Bed A.

Date.	Capacity in Gallons.	Remarks.
November 15th, 1898	4,530	3 hours rest.
December 14th, „	4,140	4½ hours rest.
January 10th, 1899	3,816	3½ hours rest.

(3) What was the water-holding capacity of coarse beds at end of experiment?

If the measurement was made after resting, please give the duration of the resting.

(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?

(*b*) What was the depth of this bed?

3 feet.

(*c*) What was the nature and size of the filtering material?

Bed B. Screened clinker. Rough material round the drain pipes. Material uniform through the bed. Passed 1-inch mesh, rejected by ¼-inch mesh.

(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.

Bed B.

Date.	Capacity in gallons.	Remarks.
November 16th, 1898	4,530	3 hours rest. (drainage pipes full).
January 10th, 1899	3,960	3 hours rest.

(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.

Appendix 9C.

(6) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.

Date.	Number of fillings.	Cycle.
November 17th, 1898, to February 8th, 1899.	3	(*a*) $\frac{3}{4}$, (*b*) 1 hour, (*c*) $\frac{3}{4}$, (*e*) 4 hours. (*a*) $\frac{3}{4}$, (*b*) 2 hours, (*c*) $\frac{3}{4}$, (*e*) $2\frac{1}{2}$ hours. (*a*) $\frac{3}{4}$, (*b*) 2 hours, (*c*) $\frac{3}{4}$, (*e*) 8 hours.
February 8th to February 15th, 1899.	4	Time of filling 6 a.m. to 12 noon, and 6 p.m. to 12 midnight. Cycle. (*a*) $\frac{3}{4}$, (*b*) 2 hours, (*c*) $\frac{3}{4}$, (*e*) $2\frac{1}{2}$ hours.

(7) State by what method the settled sewage was distributed on the beds.

By wooden shoots, perforated at the bottom of the sides.

(8) What was the average quantity of sewage in gallons dealt with daily?

10,970 (allowing for Sunday's rest).

(9) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Daily, except Sundays. Samples shaken before analysis.

(11) Give (*a*) the average of the analyses of the final effluent from the beds.

The following numbers are the average of daily analyses of final effluent (Bed B):—

Four hours oxygen absorption - - -	1·18
Incubator test, 3 mins. oxygen absorption, before - - - - - - -	·63
Incubator test, 3 mins. oxygen absorption, after - - - - - - -	·54
Putrescibility - - - - - -	23/237
Ammoniacal nitrogen - - - -	·69
Albuminoid nitrogen - - - - - -	·075
Nitrous nitrogen - - - - -	·021
Nitric nitrogen - - - - - -	·293
Chlorine - - - - - - - -	13·3

(*b*) the best analysis of the final effluent and date when sample was taken; and

(*c*) the worst analysis of the final effluent and date when sample was taken.

(*d*) the average of the estimations made of the solids in suspension in the settled sewage as it went on to the coarse bed.

About 41 parts per 100,000. (Data limited).

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

About 2·8 parts per 100,000.

(12) Give a typical analysis of the crude sewage to which the experiment relates.

The following members are the average of daily analyses of *settled sewage* for the quarter ending December 28th, 1898:—

4 hours oxygen absorption - - -	7·21
3 minutes oxygen absorption - - -	3·86
Ammoniacal nitrogen - - - -	2·27
Albuminoid nitrogen - - - -	·33
Chlorine - - - - - - -	16·0

(13) Between what dates was the experiment conducted?

November 10th, 1898, to February 15th, 1899.

If there were any periods of rest, state their duration.

Rested every Sunday, and one day on December 24th, 1898.

(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

(15) Was any nuisance caused by the experimental works?

No.

(16) Is the experiment still proceeding?

No.

If so, may the Commission inspect the works, should they deem it desirable to do so?

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(17) Give particulars of any other observations of importance which were recorded.	A considerable accumulation of silt occurred in the bed, the coarse clinker permitting the free access of sludge both into the body of the bed, and even into the drains below.
(18) What inferences have been drawn from the experiment?	It is not advantageous to attempt to purify sewage on contact beds without previous settlement. Further, it does not appear that material of the size of that in bed As is suited to the purpose of a contact bed, as it permits suspended matter freely to penetrate into the body of the bed, finally tending to form an almost impervious mass, which rapidly interferes with the action of the bed. In any case, even if clogging does not take place to such an extent, the suspended matter which passes away increases the burden for the secondary bed.
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "Subsidence tanks" is intended to denote tanks which are used so that little or no "Septic" action is produced.

Signature of Officer under whose direction the experiment was conducted

Appendix 9C. Form E.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority	Wellington, Somerset, Urban Council.
Population of district	The whole district, 6,800.
Water supply per head of the population	Twenty gallons per day.
Estimated or measured dry weather flow of sewage	120,000 gallons per day in drainage area.
Is any trade refuse taken into the sewers?	None.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially.
Officer under whom the experiment has been conducted.	Council's surveyor.
Name and qualification of chemist who has made the analyses.	Dr. Alford, County Analyst.
(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	9,380 gallons.
(*b*) What was the depth of these beds?	3 ft. 6 in.
(*c*) What were the nature and size of the filtering material?	Broken brick and tile rubble to pass a $2\frac{1}{2}$-inch ring.
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No measurements taken, as beds were not considered water-tight, being simply excavations in the ground.
(3) What was the water-holding capacity of the coarse beds at end of experiment?	
If the measurement was made after resting, please give the duration of the resting.	Answer given under (2).
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	Same as coarse bed after being in work about 3 weeks. At first the coarse bed more than filled the fine bed.
(*b*) What was the depth of these beds?	3 ft. 6 in.
(*c*) What were the nature and size of the filtering material?	Cinders perfectly free from dust and such as would pass a $\frac{3}{4}$-in. mesh, and rejected by a $\frac{1}{4}$-in. ditto.
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not?	Answer as given under (2).
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	Answer as given under (2).
(6) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying and (*e*) resting.	Three fillings in 24 hours. The flow being intermittent, times for filling varied, but averaged 1 hour to fill, $1\frac{1}{2}$ stand full, 1 to discharge, $1\frac{1}{2}$ rest. The working was carried out at one out of several of our present outfalls.
(7) State by what method the sewage was distributed on the beds.	The sewage was distributed by open wooden trunks.
(8) What was the average quantity of sewage in gallons dealt with daily?	About 28,000 gallons.
(9) Was the quantity of sewage dealt with increased in time of storm?	
If so, state to what extent, and how the results were affected by such increase.	In times of heavy rain amounting to flood, the beds were not worked.
(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	The one sample analysed was taken directly after leaving the fine beds into the same bottle as sent to analyst without any preparation whatever.

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(11) Give (*a*) the average of the analyses of the final effluent from the beds;	Only one sample analysed (Copy of Analyst's report.) February 3, 1900. Total dissolved solids - - 33·6 grains per gallon. Chlorine in chlorides - - 4·6 " " Free ammonia - - - 0·65 per million gallons. Albuminoid ammonia - 0·20 " "
(*b*) the best analysis of the final effluent, and date when sample was taken; and	
(*c*) the worst analysis of the final effluent, and date when sample was taken;	
(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to the coarse bed;	
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	
(12) Give a typical analysis of the crude sewage to which the experiment relates.	Ordinary domestic, entirely free from trade refuse.
(13) Between what dates was the experiment conducted?	March 25, 1899, and March 25, 1900.
If there were any periods of rest, state their duration.	Two days only. On days during heavy floods.
(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	
(15) Was any nuisance caused by the experimental works?	None whatever. The beds abutted on a public footpath, but no complaint of any kind was received during the whole time the beds were in work.
(16) Is the experiment still proceeding? - - - -	No.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(17) Give particulars of any other observations of importance which were recorded.	The effluent after the first two months was at all times as clear as pump water, and entirely free from smell. Samples were taken every month, which samples were dated and kept but not analysed. I noticed that whereas for the first three weeks or a month the sewage in rough bed more than filled the fine one—after which it only filled it to a little under the surface of medium.
(18) What inferences have been drawn from the experiment?	I consider it is a successful mode of treatment. Moreover I had an examination made of both beds after stopping work a few days, by having a large hole taken out in each and found that there was entire absence of any sludge, either adhering to the filtering medium or in the bottom of the beds.
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	Yes, I think it would.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers?	We shall have to lift the sewage about 60 ft., and I estimate the cost approximately at 30*s.* per head.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan?	Cannot speak with any accuracy, but I am of opinion the cost would not exceed 1*s.* per head.

Note.—It is requested that all analyses may be stated in parts per 100,000, and the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

E. T. HOWARD.
Signature of Officer under whose direction the experiment was conducted.

Appendix 9C.

Form E.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority	County Borough of West Bromwich.
Population of district	In 1891, 59,489.
Water supply per head of the population	About 20 gallons per day.
Estimated or measured dry weather flow of sewage	About 1,250,000 gallons per day, total from both levels.
Is any trade refuse taken into the sewers?	Practically none.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Wholly excluded.
Officer under whom the experiment has been conducted	Borough Engineer and Surveyor.
Name and qualification of chemist who has made the analyses.	H. Silvester, F.I.C., F.C.S., Borough Analyst.
(1) (a) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	About 52,500 gallons, taking it at one-third the capacity of bed.
(b) What was the depth of these beds?	Average 3 feet 6 inches.
(c) What were the nature and size of the filtering material?	Screened engine ashes ½-inch to 2-inch mesh.
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	After the beds had worked for 12 months, during which time they dealt with 813 fillings, a Siemens patent meter was fixed at the outlet and readings taken. The beds had not rested except on Sundays. It should here be stated that the low level sewage flows direct from the sewer on to the beds, there being no detritus tanks, consequently a large quantity of mineral matter finds its way into the beds.
(3) What was the water-holding capacity of the coarse beds at end of experiment?	After 12 months 29,455 gallons average of 12 readings.
If the measurement was made after resting, please give the duration of the resting.	
(4) (a) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	About 45,000 gallons, taking it at one-third the capacity of bed.
(b) What was the depth of these beds?	Three feet average.
(c) What were the nature and size of the filtering material?	Screened engine ashes ¼-inch to ½-inch mesh.
(5) (a) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	The meter was fixed to this bed after 12 months working.
(b) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	33,337 gallons, average of 12 readings.
(6) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Three fillings every 24 hours, Sundays excepted, (*a*) 1½ hours, (*b*) 2 hours, (*c*) emptying, 1½ hours, resting 3 hours every 8 hours.
(7) State by what method the sewage was distributed on the beds.	By iron troughs 15 inches wide.
(8) What was the average quantity of sewage in gallons dealt with daily?	Estimated at 150,000 gallons at commencement.
(9) Was the quantity of sewage dealt with increased in time of storm?	No
If so, state to what extent, and how the results were affected by such increase.	

Appendix 9C.

ANALYSES of SAMPLES of SEWAGE and EFFLUENTS after Bacteria Treatment from Friar Park Sewage Farm, West Bromwich, by *H. Silvester*, F.I.C., F.C.S., Borough Analyst.

(Quantities stated in parts per 100,000.)

LOW LEVEL.

Date.	Sample No.	No. of filling.	CRUDE SEWAGE.							
			Chlorine.	Oxygen absorbed in 4 hours.	Nitrogen as Nitrites and Nitrates.	AMMONIA.		Solids in Solution.	Solids in Suspension.	Total Solids.
						Free.	Albuminoid.			
6 November	1	10	18·40	1·630	Nil	2·715	·085	103·0	12·4	115·4
14 ,, -	2	23	20·00	2·680	,,	5·445	·409	117·0	19·6	136·6
22 ,, -	3	40	18·90	·632	,,	2·320	·100	103·0	15·6	118·6
29 ,, -	4	58	22·60	4·651	,,	4·800	·450	142·0	89·2	231·2
19 December -	5	90	24·40	5·865	,,	4·312	·470	128·0	67·6	195·6
9 January -	6	134	15·00	·434	Traces	·920	·090	136·0	2·0	138·0
16 ,, -	7	154	11·80	1·012	Nil	1·609	·120	101·0	94·0	195·0
31 ,, -	8	192	20·89	4·706	,,	3·630	·390	132·0	43·2	175·2
7 March -	9	258	22·30	4·056	,,	4·500	·334	140·0	55·44	195·44
21 ,, -	10	292	24·00	6·306	,,	4·400	·410	136·3	262·8	399·1
29 ,, -	11	312	21·80	3·147	,,	4·372	·258	117·5	86·4	203·9
6 April -	12	330	21·05	2·980	,,	3·268	·240	116·5	29·8	146·3
23 ,, -	13	371	19·35	3·258	,,	5·882	·452	118·4	228·2	346·6
23 May - -	14	445	28·70	4·244	,,	4·442	·516	135·5	64·8	200·3
29 June - -	15	519	23·90	2·706	,,	4·640	·302	117·0	63·9	180·9
25 July - -	16	581	20·80	3·693	,,	4·209	·380	118·0	35·2	153·2
30 August -	17	666	21·20	3·503	,,	6·020	·458	116·5	189·2	305·7
26 September	18	731	18·60	3·015	,,	5·140	·286	114·7	34·0	148·7
Averages -	—	—	20·75	3·251	—	4·034	·319	121·8	77·39	199·2

Date.	Sample No.	No. of filling.	EFFLUENT FROM COARSE BACTERIA BED.								
			Chlorine.	Oxygen absorbed in 4 hours.	Nitrogen as Nitrites and Nitrates.	AMMONIA.		Solids in Solution.	Solids in Suspension.	Total Solids.	Percentage of Purification.
						Free.	Albuminoid.				
6 November	1	10	18·00	·735	Traces	2·090	·050	111·0	·4	111·4	55·0
14 ,, -	2	23	19·00	·731	,,	4·200	·120	114·0	4·0	118·0	72·7
22 ,, -	3	40	19·00	·460	,,	1·300	·071	104·2	4·8	109·0	27·2
29 ,, -	4	58	21·00	2·500	,,	2·900	·226	131·6	16·4	148·0	46·2
19 December -	5	90	27·20	3·200	,,	3·270	·355	140·0	21·4	161·4	45·4
9 January -	6	134	15·00	·380	,,	·800	·060	124·0	·8	124·8	12·4
16 ,, -	7	154	13·10	·654	,,	·960	·073	107·4	1·6	109·0	35·3
31 ,, -	8	192	19·00	1 859	,,	2·260	·182	128·0	10·8	138·8	60·5
7 March -	9	258	21·30	1·608	,,	2·480	·212	143·9	12·6	156·5	60·3
21 ,,	10	292	23·40	3·793	,,	1·800	·228	124·4	6·8	131·2	39·8
29 ,, -	11	312	21·60	1·411	,,	2·960	·176	111·1	9·4	120·5	55·1
6 April -	12	330	20·65	1·041	,,	2·560	·152	104·7	6·8	111·5	65·0
23 ,,	13	371	18·90	1·077	,,	2·640	·168	107·5	6·2	113·7	66·9
23 May - -	14	445	24·90	1·613	,,	2·234	·220	119·8	9·2	129·0	61·9
29 June -	15	519	24·40	·953	,,	2·840	·208	111·5	5·6	117·1	64·8
25 July - -	16	581	22·10	1·923	,,	2·240	·144	108·0	12·0	120·0	47·9
30 August -	17	66	23·00	1·461	,,	3·808	·220	107·0	13·0	120·0	58·2
26 September	18	731	19·20	1·827	,,	3·394	·188	108·1	16·4	124·1	39·4
Averages -	—	—	20·59	1·512	—	2·485	·169	117·0	9·34	125·78	—

NOTE.—In the above analyses the determinations of the free and saline ammonia, albuminoid ammonia, and oxygen absorbed were made on the sewage and effluent from the coarse bed, after the removal of the suspended matter.

Appendix 9C.

Analyses of Samples of Sewage and Effluents after Bacteria Treatment from Friar Park Sewage Farm, West Bromwich, by *H. Silvester*, F.I.C., F.C.S., Borough Analyst—*continued.*

(Quantities stated in parts per 100,000.)

LOW LEVEL—*continued.*

Date.	Sample No.	No. of filling.	EFFLUENT FROM FINE BACTERIA BED.									
			Chlorine	Oxygen absorbed in 4 hours.	Nitrogen as Nitrites and Nitrates.	AMMONIA. Free.	AMMONIA. Albuminoid.	Solids in Solution.	Solids in Suspension.	Total Solids.	Percentage of Purification.	Total percentage of Purification.
6 November	1	10	17·5	·374	·652	1·040	·035	120·0	Nil	120·0	49·1	77·0
14 ,, -	2	23	18·0	·329	·533	1·280	·050	115·0	,,	115·0	54·9	87·7
22 ,, -	3	40	19·2	·206	·491	·666	·046	113·0	—	113·0	55·2	67·4
29 ,, -	4	58	21·1	·733	Trace	1·350	·104	119·8	7·2	127·0	70·6	84·2
19 December -	5	90	26·0	·699	·115	2·240	·125	119·0	6·0	125·0	78·1	88·1
9 January -	6	134	14·9	·232	·640	·248	·046	113·0	Nil	113·0	38·9	—
16 ,, -	7	154	14·7	·395	·526	·650	·069	113·0	,,	113·0	39·6	60·9
31 ,, -	8	192	18·4	·368	·404	·240	·045	126·0	0·8	126·8	80·2	92·1
7 March -	9	258	19·8	·427	·232	·935	·056	134·9	1·7	136·6	73·4	89·4
21 ,, -	10	292	21·1	·485	·357	1·040	·082	127·0	Traces	127·0	87·2	92·3
29 ,, -	11	312	20·5	·596	·583	1·004	·072	115·0	,,	115·0	57·7	81·0
6 April -	12	330	20·5	·478	·376	·884	·061	110·0	,,	110·0	54·0	83·9
23 ,, -	13	371	18·6	·545	·634	1·042	·116	114·0	,,	114·0	49·4	83·2
23 May - -	14	445	24·1	·629	·171	·982	·056	117·0	,,	117·0	61·0	85·1
29 June -	15	519	24·0	·247	·304	1·600	·048	114·0	—	114·0	74·0	90·8
25 July - -	16	581	21·2	·497	·110	·424	·052	103·5	,,	103·5	74·1	86·5
30 August -	17	666	20·6	·454	1·038	·284	·064	108·5	,,	108·5	68·9	87·0
26 September	18	731	20·0	·545	·971	·056	·104	101·1	1·4	102·5	70·1	81·9
Averages -	—	—	20·01	·457	·447	·886	·068	115·7	·95	116·7	—	—

Date.	Sample No.	No. of filling.	EFFLUENT FROM LAND.									
			Chlorine	Oxygen absorbed in 4 hours.	Nitrogen as Nitrites and Nitrates.	AMMONIA. Free.	AMMONIA. Albuminoid.	Solids in Solution.	Solids in Suspension.	Total Solids.	Percentage of Purification.	Total percentage of Purification.
6 November	1	10	—	—	—	—	—	—	—	—	—	—
14 ,, -	2	23	—	—	—	—	—	—	—	—	—	—
22 ,, -	3	40	—	—	—	—	—	—	—	—	—	—
29 ,, -	4	58	—	—	—	—	—	—	—	—	—	—
19 December -	5	90	—	—	—	—	—	—	—	—	—	—
9 January -	6	134	13·10	·246	1·333	·056	·046	98·0	Nil	98·0	—	43·4
16 ,, -	7	154	14·60	·296	·990	·125	·026	118·0	,,	118·0	25·0	70·7
31 ,, -	8	192	—	—	—	—	—	—	—	—	—	—
7 March -	9	258	—	—	—	—	—	—	—	—	—	—
21 ,, -	10	292	19·10	·398	·952	·184	·088	120·5	Faint trace.	120·5	17·9	93·6
29 ,, -	11	312	18·00	·310	1·338	·204	·061	103·5	Nil	103·5	48·0	90·1
6 April -	12	330	19·20	·373	·928	·192	·062	111·5	Faint trace.	111·5	21·9	87·5
23 ,, -	13	371	18·50	·345	1·038	·360	·076	120·0	Trace	120·0	36·7	89·4
23 May - -	14	445	22·00	·469	·796	·276	·041	118·0	Faint trace.	118·0	25·4	88·9
29 June -	15	519	23·00	·282	1·717	·084	·044	130·0	—	130·0	—	89·5
25 July - -	16	581	21·60	·504	2·370*	·064	·056	122·5	—	122·5	—	86·3
30 August -	17	666	20·10	·336	1·153	·152	·040	101·5	Faint trace.	101·5	26·0	90·4
26 September	18	731	20·00	·406	1·015	·112	·080	103·3	—	103·3	25·5	86·5
Averages -	—	—	19·01	·360	1·239	·155	·056	113·3	—	113·3	—	—

NOTE.—In the above analyses the determinations of the free and saline ammonia, albuminoid ammonia, and oxygen absorbed were made on the sewage and effluent from the coarse bed, after the removal of the suspended matter.

* Derived from an effluent containing more nitrogen than is indicated by the corresponding fine bed sample.

Appendix C.

LOW LEVEL (Coarse-grained Beds).

Date.	No. of filling.	Time when Bed commenced to fill.	Time when filled.	Time when Valves opened to commence emptying.	Time when emptied.	Average Temperature of Sewage.	Temperature of Atmosphere before commencing to fill.	Temperature of Bed before commencing to fill.	Temperature of Bed when standing full for one hour.	Temperature of Effluent.	Temperature of Bed immediately after emptying.
1899:											
13 Dec. -	74	2.15 a.m.	3.30 a.m.	5.30 a.m.	7.0 a.m.	51	33	49	50	50	49
13 „ -	75	10.0 a.m.	11.30 a.m.	1.30 p.m.	3.0 p.m.	50	35	49	49	49	48
13 „ -	76	6.0 p.m.	7.15 p.m.	9.15 p.m.	10.45 p.m.	51	21	40	49	48	47
14 „ -	77	1.45 a.m.	3.15 a.m.	5.15 a.m.	6.45 a.m.	48	10	42	46	45	45
14 „ -	78	9.45 a.m.	11.0 a.m.	1.0 p.m.	2.30 p.m.	48	14	34	47	50	34
14 „ -	79	5.30 p.m.	6.30 p.m.	8.30 p.m.	10.0 p.m.	49	26	32	47	46	44
15 „ -	80	1.0 a.m.	2.45 a.m.	4.45 a.m.	6.15 a.m.	49	23	38	48	45	44
15 „ -	81	9.15 a.m.	10.30 a.m.	12.30 p.m.	2.0 p.m.	53	23	40	51	50	40
15 „ -	82	5.0 p.m.	6.30 p.m.	8.30 p.m.	10.0 p.m.	51	20	46	49	49	48
16 „ -	83	1.0 a.m.	2.45 a.m.	4.45 a.m.	6.15 a.m.	49	18	46	47	47	46
16 „	84	9.15 a.m.	11.0 a.m.	1.0 p.m.	2.30 p.m.	49	25	45	47	47	47
16 „	85	2.0 a.m.	3 30 a.m.	5.30 a.m.	7.0 a.m.	47	32	43	45	45	44
					Averages - - -	49·58	23·33	42	47·91	47·59	44·46

LOW LEVEL (Fine-grained Bed).

Date.	No. of filling.	Time when Bed commenced to fill.	Time when filled.	Time when Valves opened to commence emptying.	Time when emptied.	Temperature of Atmosphere before commencing to fill.	Temperature of Bed before commencing to fill.	Temperature of Bed when standing full for one hour.	Temperature of Effluent.	Temperature of Bed immediately after emptying.
1899:										
13 Dec. -	74	5.30 a.m.	7.0 a.m.	9.0 a.m.	10.30 a.m.	34	48	50	49	48
13 „ -	75	1.30 p.m.	3.0 p.m.	5.0 p.m.	6.30 p.m.	29	36	48	48	47
13 „ -	76	9.15 p.m.	10.45 p.m.	12.45 p.m.	2.15 a.m.	21	44	47	47	46
14 „	77	5.15 a.m.	6.45 a.m.	8.45 a.m.	10.15 a.m.	12	43	46	42	40
14 „ -	78	1.0 p.m.	2.30 p.m.	4.30 p.m.	6.0 p.m.	20	34	48	46	40
14 „	79	8.30 p.m.	10.0 p.m.	12.0 p.m.	1.30 a.m.	26	45	46	46	45
15 „ -	80	4·45 a.m.	6.15 a.m.	8.15 a.m.	9.45 a.m.	23	44	47	46	45
15 „ -	81	12.30 p.m.	2.0 p.m.	4.0 p.m.	5.30 p.m.	18	46	49	46	45
15 „	82	8.30 p.m.	10.0 p.m.	12.0 p.m.	1.30 a.m.	20	45	46	46	45
16 „ -	83	4.45 a.m.	6.15 a.m.	8.15 a.m.	9.45 a.m.	19	46	46	46	45
16 „ -	84	1.0 p.m.	2.30 p.m.	4.30 p.m.	6.0 p.m.	35	43	46	45	45
16 „	85	5.30 a.m.	7.0 a.m.	9.0 a.m.	10.30 a.m.	32	42	45	45	44
					Averages - - -	24	43	47	46	44·58

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(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Samples were analysed at various dates between November 6th, 1899, to September 26th, 1900, 18 in all.
(11) Give (*a*) the average of the analyses of the final effluent from the beds;	*See* table at page .
(*b*) the best analysis of the final effluent and date when sample was taken; and (*c*) the worst analysis of the final effluent and date when sample was taken;	*See* table at page .
(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to the coarse bed;	77·39 parts per 100,000 or 54·17 grains per gallon.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	·95 parts per 100,000 or ·66 grains per gallon. Non-putrescible.
(12) Give a typical analysis of the crude sewage to which the experiment relates.	*See* foregoing tables.
(13) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	Commenced October 3rd, 1899, and extended to November 1st, 1900; beds rested from December 5th to 12th, 1899, and Sundays.
(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	*See* table at page .
(15) Was any nuisance caused by the experimental works?	None whatever.
(16) Is the experiment still proceeding? - - - -	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes, only too pleased.
(17) Give particulars of any other observations of importance which were recorded.	*See* report.
(18) What inferences have been drawn from the experiment?	The final effluent is clear, entirely without odour, remains perfectly sweet on keeping, is not liable to secondary offensive or putrefactive decomposition, and is fit to discharge into the River Tame. However small the relative volume, the effluents have always been better than the water in the River Tame, and would improve the river, and there is no doubt that the whole of the sewage of West Bromwich can successfully be treated by this system without the aid of land.
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	A scheme has been prepared for dealing with the whole of the sewage of the borough and adopted by the Council.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers;	About 5s.; this includes detritus tanks.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	About a halfpenny per head if the effluents could go direct from the fine beds into the stream, if they had to be pumped back on to the land it would increase the cost to 2½d. per head, excluding any annual charges on the machinery.

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

ALBERT D. GREATOREX, Assoc. M. Inst. C. E.,
Borough Engineer and Surveyor.

Signature of Officer under whose direction the experiment was conducted.

Form E.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority	Wigston Magna Urban District Council.
Population of district	9,048 (estimated).
Water supply per head of the population	12½ gallons per day (estimated).
Estimated or measured dry weather flow of sewage?	121,815 gallons per day (measured).
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Yes, from dye works, about 1·64 per cent.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Very little excluded, except during a severe storm, when the overflow chamber is then in use.
Officer under whom the experiment has been conducted	Surveyor to the Council.
Name and qualification of chemist who has made the analyses.	Dr. C. Coles, M.D., D.P.H., Medical Officer of Health and Analyst to the Council.
(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	3,172 gallons, when it commenced to overflow.
(*b*) What was the depth of these beds?	4 feet, *i.e.*, six inches above invert of overflow pipe.
(*c*) What were the nature and size of the filtering material?	¾-inch burnt (ballast) clay.
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	None made.
(3) What was the water-holding capacity of the coarse beds at end of experiment?	3,011 gallons, when it commenced to overflow.
If the measurement was made after resting, please give the duration of the resting.	After 17 hours resting.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	No measurement made. It was constructed the same size as the coarse bed, and was then sufficiently large to take the whole of the effluent from the coarse bed, without overflowing.
(*b*) What was the depth of these beds?	4 feet, *i.e.*, six inches above invert of overflow pipe.
(*c*) What were the nature and size of the filtering material?	½-inch cinder to 3 feet 6 inches in depth, then covered to 6 inches in depth with ½-inch burnt ballast.
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	None made.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	None made.
(6) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Fillings 1·52 on the average per diem. (*a*) Average time to fill bed about 2½ hours. (*b*) Two hours. (*c*) Seventy minutes. (*e*) Two hours after each emptying (also each night and each Sunday).
(7) State by what method the sewage was distributed on the beds.	By wooden troughs.
(8) What was the average quantity of sewage in gallons dealt with daily?	4703·5 gallons.
(9) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	The contact beds were not used in time of storm on account of the road detritus that would be washed from the macadamized roads into the sewers.

Appendix 9C.

(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Analyses were made at no definite intervals. Samples shaken up—not filtered—so as to get fair specimens.
(11) Give (*a*) the average of the analyses of the final effluent from the beds ;	Oxygen absorbed in 4 hours at 80° F. 1·39 parts per 100,000.
(*b*) the best analysis of the final effluent and date when sample was taken ; and	13th December 1899. Sewage, 7·6 parts oxygen absorbed per 100,000. Final effluent, ·33 ,, ,, ,, ,, ,, = 95·6 per cent. reduction.
(*c*) the worst analysis of the final effluent and date when sample was taken ;	23rd September 1899. Sewage :—9·45 parts oxygen absorbed per 100,000. Effluent, 3·42 ,, ,, ,, ,, ,, = 63·8 per cent. reduction.
(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to the coarse bed ;	None made.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible ?	None made.
(12) Give a typical analysis of the crude sewage to which the experiment relates.	Oxygen absorbed. Parts per 100,000. Sewage, 9·16. Effluent, coarse bed, 3·6. ,, fine bed, 2·23. Strong sewage. Sewage, 3·8. Effluent, coarse bed, ·82. ,, fine ,, ·67 Weak sewage.
(13) Between what dates was the experiment conducted ?	March 1899 and October 1900.
If there were any periods of rest, state their duration.	Seven days beside each night and each Sunday.
(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	None made.
(15) Was any nuisance caused by the experimental works ?	No.
(16) Is the experiment still proceeding ?	The contact beds are still being used and work satisfactorily.
If so, may the Commission inspect the works, should they deem it desirable to do so ?	Yes.
(17) Give particulars of any other observations of importance which were recorded.	
(18) What inferences have been drawn from the experiment ?	That the method tried gives good results for average strengths of sewage. That the final effluent of an average sewage is fit to pass into a stream. That a collection of sewage should be made in a large tank open or closed so as to give a fair average strength of sewage for treatment in the contact beds.
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	Yes.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	Approximate estimate from 14*s*. to 16*s*. per head.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	From 6*d*. to 9*d*. per head.

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Only oxygen absorbed from permanganate used for determining the purification of the sewage.

WM. GEO. J. CLARK.
Signature of Officer under whose direction the experiment was conducted.

Form E. Appendix 9C.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority	Withington Urban District Council.
Population of district	Estimated at 36,000. Adjoining district of Levenshulme, 12,000, also received and dealt with at our sewage works.
Water supply per head of the population	About 30 gallons per day.
Estimated or measured dry weather flow of sewage	About 2,500,000 gallons per day, of which 1,000,000 gallons is subsoil water from old sewers, etc.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	A small quantity from Levenshulme Bleach Works, but quantity may be neglected.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Practically the whole of the roof and surface water is taken into the sewers.
Officer under whom the experiment has been conducted.	Surveyor to the Urban District Council
Name and qualification of chemist who has made the analyses.	C. Estcourt, Esq., City Analyst, Manchester.
(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	56 per cent., or 20,317 gallons.
(*b*) What was the depth of these beds?	2·25 ft.
(*c*) What were the nature and size of the filtering material?	Crushed clinker from destructor averaging 1 to 2 ins. longest measure.
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	No experiments made.
(3) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	56 per cent., or 20,317 gallons.
(*b*) What was the depth of these beds?	2·25 ft.
(*c*) What were the nature and size of the filtering material?	Crushed clinker from destructor averaging ¼ to 1 in., longest measure.
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	No experiments made.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	
(6) State method of working of contact beds, *i.e.*, number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	2 fillings per diem—in 12 hours; 1 hour filling, 2 hours standing full, 1½ hours emptying, 2 hours resting.
(7) State by what method the sewage was distributed on the beds.	By wooden troughs.
(8) What was the average quantity of sewage in gallons dealt with daily?	40,634 gallons.
(9) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No experiments made.

Appendix 9C.

(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Once only on 3rd August, 1899.
(11) Give (*a*) the average of the analyses of the final effluent from the beds ; (*b*) the best analysis of the final effluent and date when sample was taken ; and (*c*) the worst analysis of the final effluent and date when sample was taken ; (*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to the coarse bed ; (*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	See table below. The foregoing results show this effluent is sufficiently pure to be well within the limits of pollution laid down by the Mersey and Irwell Joint Committee by sewage effluents.
(12) Give a typical analysis of the crude sewage to which the experiment relates.	None.
(13) Between what dates was the experiment conducted? If there were any periods of rest state their duration.	None.
(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	None.
(15) Was any nuisance caused by the experimental works?	None.
(16) Is the experiment still proceeding? If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(17) Give particulars of any other observations of importance which were recorded.	None.
(18) What inferences have been drawn from the experiment?	That the "Bacterial" treatment is satisfactory as far as can be judged from the analysis.
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.	About £2 per head.
(*b*) What would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.	About 7*d*. per head.

—	Grains per gallon.
Chlorine, combined	4·26
Meal ammonia	0·4750
Albuminoid ammonia	0·520
Nitrogen as nitrites and nitrates	0·060
Oxygen absorbed in 4 hours	0·332
Total solid matter at 212° F.	38·00
Mineral solid matter on ignition	20·00
Volatile matter	18·00
Appearance slightly opalescent	
To test paper slightly alkaline	

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

A. H. Mountain, Surveyor.

Signature of Officer under whose direction the experiment was conducted.

Form E. Appendix 9C.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority	Urban District Council of Withnell.
Population of district	3,750 (estimated).
Water supply per head of the population	Nine gallons per day.
Estimated or measured dry weather flow of sewage	25,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	No.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Yes.
Officer under whom the experiment has been conducted.	T. Beaver, Surveyor.
Name and qualification of chemist who has made the analyses.	None made.
(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	5,000 gallons.
(*b*) What was the depth of these beds?	3 feet 3 inches.
(*c*) What were the nature and size of the filtering material?	Furnace ashes. To pass a 2-inch mesh retained on a 1-inch mesh.
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	None made.
(3) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	None made.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	5,500.
(*b*) What was the depth of these beds?	3 feet 3 inches.
(*c*) What were the nature and size of the filtering material?	To pass 1-inch mesh and retained on ½-inch mesh.
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	None made.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	None made.
(6) State method of working of contact beds, *i.e.*, number of fillings per day of 24 hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	Two fillings per day. (*a*) Two hours. (*b*) Two hours (*c*) One hour. (*e*) Two hours.
(7) State by what method the sewage was distributed on the beds.	By means of wood troughs.
(8) What was the average quantity of sewage in gallons dealt with daily?	10,000 gallons.
(9) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No; passed on to land.

Appendix 9C.

(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	None made.
(11) Give (*a*) the average of the analyses of the final effluent from the beds.	Not known.
(*b*) The best analysis of the final effluent and date when sample was taken, and	
(*c*) The worst analysis of the final effluent and date when sample was taken.	Not known.
(*d*) The average of the estimations made of the solids in suspension in the sewage as it went on to the coarse bed.	Not known.
(*e*) The average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?	Not known.
(12) Give a typical analysis of the crude sewage to which the experiment relates.	Domestic sewage.
(13) Between what dates was the experiment conducted?	May 1899 to date.
If there were any periods of rest, state their duration.	
(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.	Not taken.
(15) Was any nuisance caused by the experimental works?	No.
(16) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(17) Give particulars of any other observations of importance which were recorded.	
(18) What inferences have been drawn from the experiment?	That it is a good preliminary treatment before passing the sewage on to land.
(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	£1 per head.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	6*d*. per head.

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus:

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

THOMAS BEAVER.
Signature of Officer under whose direction the experiment was conducted.

Form E.

Appendix 9C.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE IN CONTACT BEDS. (DOUBLE CONTACT.)

Name of authority	Corporation of York.
Population of district	About 75,000.
Water supply per head of the population	33 gallons per day.
Estimated or measured dry weather flow of sewage	45 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Trade refuse is so small as to be negligible.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Storm water above the capacity of the sewers.—Yes. Soil or surface.—No.
Officer under whom the experiment has been conducted.	City engineer.
Name and qualification of chemist who has made the analyses.	(*a*) Thomas Fairley, F.I.C., F.R.S.Edin.; F.C.S. London. &c., &c. (*b*) Edmund Moody Smith, M.D., C.M.Edin.; D.P.H. Cam. Medical Officer of Health, York.

(1) (*a*) What was the water-holding capacity at commencement of experiment of the coarse beds when filled with the filtering material?	18,550 gallons.
(*b*) What was the depth of these beds?	3ft. 3in.
(*c*) What were the nature and size of the filtering material?	All rejected by $1\frac{1}{4}$ in. screen.
(2) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of coarse beds, stating in each case whether the measurement was made after resting or not.	See table below.

1899:	Gallons.	
On 13 June	18,550	—
„ 11 September	9,360	—
„ 25 September	13,650	After 14 days rest.
„ 6 November	9,600	—
„ 27 November	12,750	Rest.
„ 11 December	9,900	—
„ 26 December	11,000	58 hours rest.

* On the 1st filling after 14 days rest a large quantity of sludge was unfortunately washed out of the supply pipe on to the bed.

(3) What was the water-holding capacity of the coarse beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	It has never been less than 9,360 gallons after resting for Sunday.
(4) (*a*) What was the water-holding capacity at commencement of experiment of the fine beds when filled with the filtering material?	Not ascertained. The flow from No. 1 has never filled No. 2 more than 2 ft. in depth with liquid.
(*b*) What was the depth of these beds?	3 ft 3 in.
(*c*) What were the nature and size of the filtering material.	Clinker and coke $\frac{3}{8}$ to $\frac{7}{8}$ in.
(5) (*a*) Give particulars of measurements made from time to time during the experiment of the water-holding capacity of the fine beds, stating in each case whether measurement was made after resting or not.	Not ascertained. The effluent from No. 1 bed only filled No. 2 for about two ft. in depth, and on no occasion has it been necessary to fork over the surface.
(*b*) What was the water-holding capacity of fine beds at end of experiment? If the measurement was made after resting, please give the duration of the resting.	Not ascertained, The surface of this bed has remained clear of any deposit throughout.
(6) State method of working of contact beds, *i.e.* number of fillings per day of twenty-four hours, and periods of (*a*) filling, (*b*) standing full, (*c*) emptying, and (*e*) resting.	8 hour cycles: (*a*) $1\frac{1}{4}$ filling, (*b*) 2 standing full (*c* and *e*) $4\frac{3}{4}$ hours.

Appendix 9C.

(7) State by what method the sewage was distributed on the beds.

Run on in semi-circular glazed drain pipes.

(8) What was the average quantity of sewage in gallons dealt with daily?

About 33,000 gallons.

(9) Was the quantity of sewage dealt with increased in time of storm?

If so, state to what extent, and how the results were affected by such increase.

No.

(10) State at what intervals analyses of the effluent were made and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Weekly, monthly, and at longer intervals. Allowed to clear by standing.

(11) Give (*a*) the average of the analyses of the final effluent from the beds.

Total solids	72·58
Mineral matter	67·58
Volatile and organic matter	5·0
Free ammonia	1·21
Albuminoid ammonia	·145
Nitrogen as calcium nitrate	Nil.
Nitrogen as nitrites	Nil.
Oxygen required to oxidise organic matter in 4 hours.	·643
Reaction	Alkaline.
Chlorine	12·15
Sediment	·096
Analyst	Mr. Fairley.

(*b*) the best analysis of the final effluent and date when sample was taken, and

(*c*) the worst analysis of the final effluent and date when sample was taken.

—	Best. 22 November, 1899. Bed No. 1.	Best. 22 November, 1899. Bed No. 2.	Worst. 1 August 1899.
Total solids	99·11	95·67	79·7
Mineral matter	91·68	74·3	74·3
Volatile and organic matter	7.43	5·4	5·4
Free ammonia	2·8	1·44	1·65
Albuminoid ammonia	·186	·157	·2
Nitrogen as calcium nitrate	Nil	7·6	Under ·01
Nitrogen as nitrites	Trace	Trace	—
Oxygen required to oxidise organic matter in 4 hours	·643	·328	·957
Reaction	Alkaline	Alkaline	Alkaline
Smell (when cold)	None	None	Very faint
Chlorine	20·3	17·74	14·54
Sediment	3·88	Trace	—
Containing organic matter	2·97	Trace	—
Analyst	Mr. Fairley		

(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to the coarse beds.

Not ascertained.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these putrescible?

Trace only. No.

(12) Give a typical analysis of the crude sewage to which the experiment relates.

Total solids	83·67
Mineral matter	69·51
Volatile and organic matter	14·157
Free ammonia	5·0
Albuminoid ammonia	0·7
Nitrogen as calcium nitrate	Nil.
Nitrogen as nitrites	Nil.
Oxygen required to oxidise organic matter in 4 hours	4·3
Reaction	Alkaline.
Smell (when cold)	Very offensive.
Chlorine	12·63
Sediment	30·41
Containing organic matter	21·84
Analyst	Mr. Fairley

Appendix 9C.

(13) Between what dates was the experiment conducted

From June 1899 to October 1900, with crude sewage since that date with open septic tank effluent.

If there were any periods of rest state their duration.

Every Sunday.

(14) Give particulars of any observations which may have been made of the temperatures of the contact beds at different depths.

The following are typical temperatures taken at the bottom of No. 1 bed, when the outside temperature has been under 35 or over 45.

Date.	Hour.	Atmosphere.	Bed.	Date.	Hour.	Atmosphere.	Bed.
1900 : 29 November -	10 a.m.	46	47	1900 : 29 December -	9 p.m.	31	42
11 December -	9 a.m.	46	45	1901 : 1 January -	9 p.m.	30	40
12 ,, -	9 a.m.	52	44	2 ,, -	9 a.m.	28	40
12 ,, -	9 p.m.	50	45	2 ,, -	9 p.m.	28	41
13 ,, -	9 a.m.	48	48	3 ,, -	9 a.m.	30	41
14 ,, -	9 a.m.	48	48	3 ,, -	9 p.m.	28	41
14 ,, -	9 p.m	48	48	8 ,, -	10 a.m.	31	41
15 ,, -	9 a.m.	47	47	9 ,, -	9.30 a.m.	23	40
15 ,, -	9 p.m.	48	47	15 ,, -	9 a.m.	30	43
20 ,, -	9 a.m.	50	47	15 ,, -	9 p.m.	30	43
20 ,, -	9 p.m.	54	48	16 ,, -	9 a.m.	27	41
21 ,, -	9 a.m.	46	46	21 ,, -	9 p.m.	46	43
25 ,, -	9 a.m.	50	44	22 ,, -	9 a.m.	46	45
25 ,, -	9 p.m.	50	46	23 ,, -	9 p.m.	30	44

(15) Was any nuisance caused by the experimental works?

No.

(16) Is the experiment still proceeding?

Terminated in October last

If so, may the Commission inspect the works should they deem it desirable to do so?

Yes.

(17) Give particulars of any other observations of importance which were recorded.

The first bed had to be forked over from time to time, and on one occasion about ¾ of a cubic yard of solid matted matter was removed from the surface.

(18) What inferences have been drawn from the experiment?

That this method is superior to chemical precipitation, but not equal to open septic tank treatment followed by continuous filtration.

(19) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state.

It is practicable but is not considered expedient in view of the superior results obtained by experiment referred to in form G.

(*a*) What would be the estimated capital cost per head of constructing the works of disposal—excluding the cost of land and cost of sewers.

(*b*) What would be the estimated annual cost per head of purifying the sewage by this system—excluding the annual repayment of any loan.

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be stated in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

This cannot now be done, the analyses are given as received. A standard form for sewage analyses is very much needed.

A. Creer.

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form G.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK FOLLOWED BY CONTINUOUS FILTRATION.

Name of authority - - - - - - - -	Acton District Council.
Population of district - - - - - - -	About 36,000. The drainage from about 18,000 persons goes to the Council's Sewage Works, all other drainage to the Sewers of the London County Council.
Water supply per head of the population - - -	
Average measured dry weather flow of sewage - -	674,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Hardly any trade refuse except the waste waters from laundries, of which there are a great number.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Only partially.
Officer under whom the experiment has been conducted.	The surveyor, assisted recently by the Medical Officer of Health.
Name and qualification of chemist who has made the analyses.	E. J. Bevan, Esq., analyst to County Council of Middlesex.
(1) (*a*) What is the capacity in gallons of the open septic tank?	146,000 gallons.
(*b*) If there was more than one tank state whether they were worked in series or in parallel.	One tank only.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	Tank first in use October 4th, 1899, and on December 20th, 1900, there was found to be a deposit at the inlet end of tank about ¼ inch thick, consisting of grit, and no deposit was found at the other end.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	No removal.
(3) (*a*) What are the form, the area and depth of the filters?	Octagonal area 66 yards superficial average depth when analysis was taken 6 feet 6 inches, afterwards increased. *See answer to Q.* 10.
(*b*) State the nature and size of the filtering material	Broken clinker about 2 inch gauge.
(*c*) Were the sides of the filters open or closed? -	Open.
(4) What was the rate of filtration in gallons per square yard per 24 hours?	500 gallons per square yard per 24 hours.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	Not reduced, except as mentioned in answer to Q. 15.
(5) What was the average quantity of sewage in gallons dealt with daily?	Amount filtered, 33,000 gallons per 24 hours.
(6) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	No, though the sewage would be diluted.
(7) State by what method the tank liquor was distributed on the filters.	By revolving sprinklers (Whittaker and Bryant's.)
(8) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	One analysis only taken. A sample was taken every hour for 12 hours on one day, the samples mixed, and a gallon of the mixture was sent to the analyst.
(9) Give (*a*) the average of the analyses of the final effluent from the filters.	Analysis by Mr. E. J. Bevan on March 27th, 1900. (see below) This is the only analysis taken.
(*b*) the best analysis and date when sample was taken, and	
(*c*) the worst analysis and date when sample was taken	
(*d*) solids in suspension in the tank liquor as it went on to the filters	1·50 on March 27th 1900.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?	

	parts per 100,000.
Total solids in solution - - - - -	84·7
Solids in suspension - - - - -	traces
Chlorine - - - - - - - -	7·5
Free ammonia - - - - - - -	1·15
Albuminoid ammonia - - - - -	·075
Oxygen absorbed - - - - - -	·54
Appearance - - - - - - -	clear
Smell - - - - - - - -	none

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(10) Give a typical analysis of the crude sewage to which the experiment relates.	Analysis by Mr. E. J. Beva on March 27th 1900. parts per 100,000 Total solids in solution - - - - - 85·0 Solids in suspension - - - - - 47·4 Chlorine - - - - - - - - 7·8 Free ammonia - - - - - - - 3·9 Albuminoid ammonia - - - - - ·335 Oxygen obsorbed - - - - - - 1·75 Appearance - - - - - - - Usual. Smell - - - - - - - - Usual.
(11) Between what dates was the experiment conducted?	
If there were any periods of rest state their duration.	
(12) Give particulars of any observations which have been made of thr temperatures of the filters at different depths.	
(13) Was any nuisance caused by the experimental works?	Complaints were last summer made as to smells from the filter. To diminish this the sewage was not allowed to rest so long in the septic tank, and the surface of the filter was raised a foot, bringing it nearer the sprinkler (the average depth of filter being now 7 ft. 6 in.) and these alterations materially diminished the smell, so that no complaints have been received since these alterations were carried out.
(14) Is the experiment still proceeding? - - - -	Yes, as also a smaller experimental filter which will probably be the model for further filters.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(15) Give particulars of any other observations of importance which have been recorded.	When the filter was started on October 4th, 1899, the sewage was allowed 106 hours to flow through the septic tank on its way to the filter, and a thick crust was formed upon the sewage in tank. In the summer of 1900 when complaints were made as to smells from the filter, the speed of the revolving sprinkler was slightly reduced, and the sprinkler was stopped on two or three occasions for repairs to the ironwork, so that the flow through the septic tank was retarded. Thereupon an ebullition took place in the tank, and gas was given off in transparent bubbles (the ordinary bubbles on the crust were black leathery looking bubbles) and the crust rapidly disappeared. The speed of the sprinkler was increased, and the tank was allowed continuously to deliver into an ordinary tank (about 176,000 gallons per day) so that the sewage took only $16\frac{3}{4}$ hours to travel through the tank, and a thick crust was formed again in a few hours.
(16) What inferences have been drawn from the experiment?	That sewage can be treated in this way, even when it has to be lifted on to the filters, more economically and with less offence, than by methods of chemical precipitation. *Note.*—The effluent from the sewage works is carried direct into the tideway of the Thames at Chiswick Eyot and therefore no high degree of purification is required by the Thames Conservancy.
(17) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	No such estimates have been made.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

D. J. Ebbets, Surveyor.

Signature of Officer under whose direction the experiment was conducted.

Form G.

Appendix 9C.

CONTINUED EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK FOLLOWED BY CONTINUOUS FILTRATION.

Name of authority - - - - -	Carshalton Urban District Council.
Population of district - - - - - - - -	6,700.
Water supply per head of the population - - -	30
Measured dry weather flow of sewage - - - -	230,000.
Is any trade refuse taken into the sewers?	No.
If so state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Wholly excluded.
Officer under whom the experiment has been conducted.	Wm. Willis Gale, A.M.I.C.E.
Name and qualification of chemist who has made the analyses.	Messrs. Dibden and Thudichum, F.I.C., F.C.S.
(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	77,000 gallons each tank.
(*b*) If there was more than one tank state whether they were worked in series or in parallel.	Three, worked in parallel one always being in reserve.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	The tanks have been receiving the whole of the sewage for upwards of 8 months and only a very slight deposit of sludge can be discovered.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	None removed.
(3) (*a*) What are the form, the area and depth of the filters?	Rectangular, 4 filters, 1,815 sq. yds. in each, or $1\frac{1}{2}$ acres in all; 4 ft. 6 in. in depth.
(*b*) State the nature and size of the filtering material.	Size. / Depth. Burnt ballast, sifted - - - - 1 in. 12 in. Mixed ballast, breeze and sandy soil - $\frac{1}{2}$ „ 36 „ Selected top soil - - - - - - 6 „
(*c*) Were the sides of the filters open or closed? - -	Closed, with side air inlets communicating with the underdrains of filters.
(4) What was the rate of filtration in gallons per square yard per 24 hours?	127 gallons per yard super.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	Not noticeable.
(5) What was the average quantity of sewage, in gallons, dealt with daily?	The whole daily flow of 230,000 gallons.
(6) Was the quantity of sewage dealt with increased in time of storm?	No.
If so, state to what extent, and how the results were affected by such increase.	No.
(7) State by what method the tank liquor was distributed on the filters.	By open half pipe channels with non stops for equal distribution.
(8) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Only one analysis made for the character of the effluent is apparent to the eye.
(9) Give (*a*) the average of the analyses of the final effluent from the filters.	Appearance - - - - Clear and bright. Odour - - - - - - Nil. Reaction - - - - - Very faintly alkaline. Chlorine - - - - - 9·71 parts per 100,000 Ammoniacal nitrogen - - ·204 „ „ „ Albuminoid „ - - ·03 „ „ „ Oxygen at once - - - Trace. „ „ in 4 hours - - - ·44 „ „ „ Nitrous nitrogen - - - Trace. Nitric nitrogen - - - 7·294 parts per 100,000 Suspended matters - - - Slight traces. „ „ volatile - „ „ Dissolved solids, total - - 144·57 parts per 100,000 „ „ volatile - - 60·14 „ „ „
(*b*) the best analysis and date when sample was taken and	10th September, 1900.

(c) the worst analysis and date when sample was taken.	10th September, 1900.
(d) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters.	Not taken.
(e) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?	Slight trace.
(10) Give a typical analysis of the crude sewage to which the experiment relates.	Oxygen absorbed ¼ hour - - 5·757 parts per 100,000 " " 4 " - - 12·90 " " " Chlorine - - - - - 10·857 " " " Ammoniacal nitrogen - - 10·90 " " " Albuminoid " - - 2·58 " " "
(11) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	No 1 tank has been in use since March, 1900. No 2 tank has been in use since May, 1900.
(12) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	None made.
(13) Was any nuisance caused by the experimental works?	When the sewage is pumped into the septic tanks a smell of sulphuretted hydrogen is apparent.
(14) Is the experiment still proceeding? If so, may the Commission inspect the works, should they deem it desirable to do so?	This is not strictly speaking an experiment, for the whole of the sewage is treated on these lines. Yes.
(15) Give particulars of any other observations of importance which have been recorded.	That the effluent absorbed impurities after passing over land. It was noticed within 8 or 9 days after these tanks were started that black masses of sludge arose from the bottom of the tanks, accompanied by bubbles of gas. After some months had elapsed these masses of sludge formed a compact and practically air-tight cover to the sewage in the tanks. This only occurred in the first two divisions, it being a difficult matter to get a scum to form on the third or last division in the tank. (Each tank is practically three tanks on account of the floating scum boards.) In frosty weather a scum arises in the last division which disperses shortly after the sun has shone on it. The inference to be drawn from this fact is that the changes going on in the body of the tanks provide automatically as it were a protection from climatic changes, so that the sewage remains in an equable condition as regards temperature. The gas bubbles can be easily ignited, and burn for a short time with energy.
(16) What inferences have been drawn from the experiment?	That the sewage by simply passing through the tanks with its three divisions is purified to the extent of 46 per cent., taking the oxygen absorbed test as a guide, and to the extent of 64 per cent. by the albuminoid ammonia test, and that nearly all the solid organic matter is digested and liquefied, the tank effluent then being in such a condition that the further treatment in the filter bed is considerably assisted.
(17) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	The whole of the sewage is now being disposed of on the lines of this system.
(a) the capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	17s., made up as follows:— £ s. d. 1,597 0 3 Tanks. 472 13 6 Sludge well. 3,622 11 11 Filters. 5,692 5 8
(b) the annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	1/7·27*d*.

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Wm. Willis Gale, A.M.I.C.E.
Signature of officer under whose direction the experiment was conducted.

Appendix 9C. Form G.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK FOLLOWED BY CONTINUOUS FILTRATION.

Name of authority - - - - - - - -	Mayor, Aldermen, and Burgesses of the Borough of Hyde.
Population of district - - - - - - -	Estimated at 32,000.
Water supply per head of the population - - -	20 gallons per day for a population of 30,000 supplied.
Estimated or measured dry weather flow of sewage -	1,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Hat works, margarine works, india-rubber works, aniline dye works, slaughter houses, tripe boiling works, &c., estimated at 25,000 gallons.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially.
Officer under whom the experiment has been conducted.	Mr. T. Carter Beeley (Mayor and Chairman of Committee), under the advice of Mr. F. Scudder.
Name and qualification of chemist who has made the analyses.	Mr. Frank Scudder, F.I.C.
(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	75,000.
(*b*) If there was more than one tank state whether they were worked in series or in parallel.	One only.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	Tank was emptied after 14 months work, the sludge remaining was 11 tons (the weekly quantity under chemical precipitation).
(3) (*a*) What are the form, the area and depth of the filters?	Whittaker and Bryant system. Circular, 43 feet diameter and 9 feet deep.
(*b*) State the nature and size of the filtering material.	Coke refused by 2 inch ring.
(*c*) Were the sides of the filters open or closed?	Open under bottom, and open for 4 feet from top all round.
(4) What was the rate of filtration in gallons per square yard per 24 hours?	600 gallons for 3 months, since that time 450 gallons.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	Reduction was not due to choking, but to obtain a better result. The alteration had immediate success.
(5) What was the average quantity of sewage in gallons dealt with daily?	75,000 gallons.
(6) Was the quantity of sewage dealt with increased in time of storm?	Constant volume taken daily into septic tank.
If so, state to what extent, and how the results were affected by such increase.	No increase taken.
(7) State by what method the tank liquor was distributed on the filters.	By revolving sprinklers (automatic), liquor being pumped from tank by pulsometer pump, Whittaker and Bryant's principle.
(8) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper, or allowed to clear by standing, before being analysed.	Weekly, by Whittaker and Bryant, Accrington, at frequent intervals by Mr. F. Scudder, analyst to the Mersey and Irwell Board.
(9) Give (*a*) the average of the analyses of the final effluent from the filters.	(*a*) Ammoniacal nitrogen, 0·62 parts per 100,000. Albuminoid nitrogen, 0·20 „ „ Residual nitrogen, not determined. Nitrous nitrogen, 0·17 parts per 100,000. Nitric nitrogen, 1·20 „ „ Oxygen absorbed 3 minutes test, 0·60 „ „ 4 hours test, 1·63 „ „ Transparency millimetres seen through, 154. Chlorine (Cl.), 26·3 parts per 100,000.
(*b*) the best analysis and date when sample was taken, and	July 5th, 1900. Ammoniacal nitrogen, 0·52 parts per 100,000. Albuminoid nitrogen, 0·17 „ „ Nitrous nitrogen, 0·16 „ „ Nitric nitrogen, 1·10 „ „ Oxygen absorbed— 3 minutes test, 0·43 „ „ 4 hours test, 1·20 „ „ Transparency millimetres seen through, 232. Chlorine (Cl.), 20·0 parts per 100,000.

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(c) the worst analysis and date when sample was taken ;	July 11th, 1899. Parts per 100,000 Ammoniacal nitrogen - - - - - 3·30 Albuminoid „ - - - - - - 0·41 Nitrous „ - - - - - - None. Nitric „ - - - - - - None. Oxygen absorbed— 3 minutes test - - - - - 1·4 4 hours test - - - - - - 2·60 Transparency millimetres seen through - 97 Chlorine (Cl.) - - - - - - 22·0
(d) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters ;	4 grains mineral. 5 grains organic. Total 9 grains per gallons.
(e) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible ? No.	1·7 grain mineral. 2·6 grain organic. 4·3 grains total per gallon.
(10) Give a typical analysis of the crude sewage to which the experiment relates.	Ammoniacal nitrogen, 4·80 parts per 100,000. Albuminoid nitrogen, 2·00 „ „ Oxygen absorbed— 3 minutes test, 3·63 „ „ 4 hours test, 11·40 „ „ Transparency, 20·0 „ „ Chlorine, 22·5 „ „
(11) Between what dates was the experiment conducted ?	June 24th, 1899, to present date.
If there were any periods of rest, state their duration.	Since October, 1900, rested nightly four to five hours, with improved results.
(12) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	Not taken. Temperature of water falling on averages 55° F.
(13) Was any nuisance caused by the experimental works ?	Not received any complaints.
(14) Is the experiment still proceeding ?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so ?	Yes.
(15) Give particulars of any other observations of importance which have been recorded.	The filter appears to have periodical slight floodings, causing pools in different parts of the filter. These always disappear in three or four days without slowing down the filter. There is a slight deposit in the final effluent, which slightly affects the analyses. This we are arranging to take out. We found it was not possible to press the sludge at the stoppage. It was so greasy (apparently) that the press cloths were coated over and refused to pass the liquid through.
(16) What inferences have been drawn from the experiment ?	We have, under the advice of Mr. F. Scudder and Messrs. Dibdin and Thudichum, and encouraged by the excellent results obtained, drawn out a complete scheme on this principle, and applied to the Local Government Board for powers. Colonel Marsh and Dr. Buchanan were the inspectors, and complete evidence was laid before them. Their decision has not yet been received.
(17) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(a) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers;	13*s.* 7*d.* per head. In addition to the money previously spent on chemical precipitation system, much of which will be again available.
(b) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	10*d.* per head.

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

T. C. Beeley (Mayor),

Signature of Officer under whose personal direction the experiment was conducted.

Appendix C Form G.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK FOLLOWING BY CONTINUOUS FILTRATION. (BED B.)

Name of authority	Manchester.
Population of district	550,000.
Water supply per head of the population	Gallons per day Domestic use - 17 Trade purposes - 11 Total - 28
Estimated or measured dry weather flow of sewage	27,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers.	Mostly enter the sewers. Storm overflows are provided at certain points which are supposed to come into action at a dilution of five to one; in certain cases however they fail to answer their purpose.
Officer under whom the experiment has been conducted	Gilbert J. Fowler, M.Sc. (Vict.), F.I.C. (Supt.)
Name and qualification of chemist who has made the analyses.	Edward Ardern, B.Sc. (Vict.) H. A. Bell, A. C. Oddie E. Hadfield, Junior Assistants. Under the direction of G. J. Fowler (Supt.)
(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	1,125,000 gallons.
(*b*) If there was more than one tank state whether they were worked in series or in parallel.	
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	
If the sludge was removed from the Septic Tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	
(3) (*a*) What are the form, the area and depth of the filters?	Square, with sloping sides. 3 ft. deep. Area at top . Area at bottom 17 ft. 6 in. square.
(*b*) State the nature and size of the filtering material	Clinker. Passed 1-in. mesh, rejected by ¼-in., with rough material round the drain.
(*c*) Were the sides of the filters open or closed?	Closed.
(4) What was the rate of filtration in gallons per square yard per 24 hours?	245 gallons per square yard per 24 hours. (Allowing for Sunday's rest.)
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	In consequence of impurity of filtrates, the method of working was altered from 12 hours continuous flow per day (February 28—March 22) to alternate periods of two hours flow, and two hours rest. (March 22—April 25).
(5) What was the average quantity of sewage in gallons dealt with daily?	15,656 gallons (after allowing for Sunday's rest).
(6) Was the quantity of sewage dealt with increased in time of storm?	No.
If so, state to what extent, and how the results were affected by such increase.	

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(7) State by what method the tank liquor was distributed on the filters.

Specially-constructed wooden shoots laid on the surface of the bed were employed, having bevelled edges, over which the open septic tank effluent passed in a thin stream, reaching the filter in drops. Considerable difficulty was experienced in getting the shoots level.

(8) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.

Daily except Sundays. Samples shaken before analysis.

(9) Give (*a*) the average of the analyses of the final effluent from the filters;

The following numbers are the average of daily analyses for the periods given :—

DATE.	Four hours Oxygen Absorption.	Incubator Test. Three Minutes Oxygen Absorption. Before.	After.	Putrescibility.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
28 February to 22 March 1900, 12 hours continuous flow and 12 hours rest during the day.	5·10	3·17	3·48	16–17	1·64	·162	·053	·193	17·1
22 March to 25 April 1900, alternate periods of two hours rest and work.	5·80	3·13	4·01	27½–28	3·09	·29	·037	·085	16·3

(*b*) the best analysis and date when sample was taken; and

(*c*) the worst analysis and date when sample was taken;

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters;

17·0 to 18·0 parts per 100,000.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?

Very fair amount. Yes.

(10) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily analyses of *Settled Sewage* for the half-year ending June 27th, 1900 :—

4 hours oxygen absorption	7·86
3 minutes oxygen absorption	3·93
Ammoniacal nitrogen	1·91
Albuminoid nitrogen	·335
Chlorine	16·3

(11) Between what dates was the experiment conducted?

From February 28th to April 25th, 1900.

If there were any periods of rest, state their duration.

Rested on Sundays.

(12) Give particulars of any observations which have been made of the temperatures of the filters at different depths.

(13) Was any nuisance caused by the experimental works?

No.

(14) Is the experiment still proceeding?

No.

If so, may the Commission inspect the works, should they deem it desirable to do so?

(15) Give particulars of any other observations of importance which have been recorded.

(16) What inferences have been drawn from the experiment?

That an arrangement such as that described does not appear to offer any advantage over the ordinary method of intermittent filtration.

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(17) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state—

(a) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers;

(b) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.

Note.—It is requested that all analyses may be stated in parts per 100,000, an that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

GILBERT J. FOWLE .

Signature of Officer under whose direction the experiment was conducted.

Form G. Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTICK TANK FOLLOWING BY CONTINUOUS FILTRATION. (STODDART FILTER.)

Name of authority - - - - - - - -	Manchester.
Population of district - - - - - -	543,902.
Water supply per head of the population - - -	28 gallons per day; 17 domestic use, 11 trade purposes.
Estimated or measured dry weather flow of sewage -	27,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Breweries, dye and bleach works, galvanising works, grease refineries, tanneries, manufactories of tar products rubber goods works, tripe-dressing works, mineral water manufactor. About 4 to 5 per cent.
Is the storm, soil or surface water, wholly or partially excluded from the ordinary sewers?	Mostly enters the sewers. Storm overflows are provided at various points which are supposed to come into action at a dilution of 5 to 1; in certain cases, however, they fail to answer their purpose.
Officer under whom the experiment has been conducted,	Gilbert J. Fowler, M.Sc. (Vict.), F.I.C. (Superintendent)
Name and qualification of chemist who has made the analyses.	Laboratory Staff: Edward Ardern, B.Sc. (Vict.), ; H. D. Bell, A. Oddie, E. Hadfield, junior assistants, under the direction of G. J. Fowler, Superintendent.

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	125,000 gallons.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	
(2) Were any observations made as to the filling up of the septic tanks by the deposit of sludge?	Yes.
If the sludge was removed from the septic tanks, state how often this was done, and, approximately, what quantity of sludge was removed on each occasion.	
(3) (*a*) What are the form, the area and depth of the filters?	Rectangular, surface area 16 square yards, depth 6 feet.
(*b*) State the nature and size of the filtering material	Chiefly large clinker, top coat of coke both 3 in. by 2 in.
(*c*) Were the sides of the filters open or closed? -	For the most part the sides were of boarding, spaces of about an inch being left between the boards. The filter being constructed near a bank some excavation was necessary and the base of the filter was surrounded by earth to a depth varying roughly from 1 to 2 ft. This was aferwards cut completely away on two sides, but the filtrate at all times could flow freely away through the 2-in. pipes into a manhole.
(4) What was the rate of filtration in gallons per square yard per 24 hours?	240 gallons.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	The rate of flow had on several occasions to be reduced on account of the quality of the filtrate.
(5) What was the average quantity of sewage in gallons dealt with daily?	3,840 gallons.
(6) Was the quantity of sewage dealt with increased in time of storm?	Not appreciably.
If so, state to what extent, and how the results were affected by such increase.	

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(7) State by what method the tank liquor was distributed on the filters.

By means of Stoddart's patent distributor. The tank effluent flows into a supply channel of cast iron and thence along perforated gutters of corrugated zinc. The perforations are cut in diamond shape at intervals along the upper edges of the corrugation. Through the lower edges small holes are made which admit ordinary nails, which serve as points from which the liquid can flow. The tank effluent flows through the diamond-shaped perforations of the distributors and falls from the ends of the nails in a series of drops.

(8) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.

Daily except Sundays. Samples were analysed both shaken and settled.

(9) Give (*a*) effluent from the filters; the average of the analyses of the final

—	Four Hours Oxygen absorption.	Three Minutes Oxygen absorption.		Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
		Before Incubation.	After Incubation.					
Shaken - -	2·96	1·74	1·67	2·02	·234	·084	·221	15·7
Settled - -	2·43	1·43	1·26	1·97	·195	—	—	—

Percentage of samples putrescent 50·7 shaken.
Percentage of samples putrescent 23·4 settled.

(*b*) the best analysis and date when sample was taken; and

(*c*) the worst analysis and date when sample was taken

It is a matter of some difficulty to say exactly which is the best and which is the worst analysis, as the different factors vary.

(*b*) Best Analysis. Sample taken 8th October, 1900.

—	Four Hours Oxygen absorption.	Three Minutes Oxygen absorption.		Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Nitrous Nitrogen.	Nitric Nitrogen.	Chlorine.
		Before Incubation.	After Incubation.					
Shaken - -	2·66	1·17	·91	1·58	·188	·223	·164	13·4
Settled - -	1·54	·77	·40	1·58	·117	—	—	—

(*c*) Worst Analysis. Sample taken 24th November, 1900.

Shaken - -	5·03	3·17	3·48	2·53	·33	Nil.	·06	18·6
Settled - -	4·88	2·91	3·28	2·47	·32	—	—	—

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters;

16·86 parts per 100,000.
The above number is the average of almost daily analyses of the tank effluent from 28th September to 26th December, 1900.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?

In the earlier stages of the experiment the amount of suspended matter contained in the filtrate was excessive. Latterly it has been about 6 grains per gallon. In many cases the suspended matter was putrescible.

(10) Give a typical analysis of the crude sewage to which the experiment relates.

The following is the average of daily analyses of raw sewage for the quarter ending 26th December, 1900:—

Four hours oxygen absorption - -	11·46
Three minutes oxygen absorption - -	5·47
Ammoniacal nitrogen - - - -	2·01
Albuminoid nitrogen - - - -	0·61
Chlorine - - - - - - -	16·6

(11) Between what dates was the experiment conducted?

From 8th August to 26th December, 1900

If there were any periods of rest state their duration

Occasionally on Sundays.

(12) Give particulars of any observations which have been made of the temperatures of the filters at different depths.

(13) Was any nuisance caused by the experimental works?	No.
(14) Is the experiment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Certainly.
(15) Give particulars of any other observations of importance which have been recorded.	One of the first things met with in connection with this filter is the difficulty experienced in getting the distributing shoots properly level, in order to ensure equal distribution. Any difference of level is of course more noticeable when the flow is small; with an increased flow it is scarcely noticed. After the filter had been working some time it was found that at the junction of the distributing channel with the shoots a considerable amount of leakage took place; this was found to be due in some degree to the partial disintegration of the felt used in making the joint. A considerable amount of sludge accumulates in the distributing channel and shoots, in a comparatively short space of time, which has to be periodically removed in order to ensure the better working of the filter. At the commencement of working a very large amount of suspended matter came away from the filter consisting largely of fine cinder, etc. This amount on further working decreased, but the filtrate always contains a fair amount of suspended matter; further settlement or rough filtration is thus necessitated. During the latter period of working, a quantity of partially disintegrated worms came away in the filtrate. Up to 27th December, the base of the filter was surrounded by earth to a depth of from one to two feet; on this date this earth was removed in order to see whether the purity of the filtrate would be affected; no appreciable difference was however found.
(16) What inferences have been drawn rom the experiment	That in order to ensure continuous filtration being successful, a tank effluent must be used containing as small amount of suspended matter as possible. Results have shown that the tank effluent used contained too much suspended matter to be dealt with by continuous filtration without further settlement. That the best results are obtained with a tank effluent possessing a low oxygen absorption value with a high albuminoid ammonia value. It appears as if, in the case of Manchester sewage, the oxidising power of the filter is exercised largely on matters other than sewage, so that nitrification is to that extent impeded.
(17) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state— (*a*) what would be the estimated capital cost per head of constructing the works of disposal excluding the cost of land and cost of sewers; (*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

GILBERT J. FOWLER.
Signature of officer under whose direction the experiment was cond cted.

Appendix 9C, Form G.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK FOLLOWED BY CONTINUOUS FILTRATION.

Name of authority	Rural District Council of Walsall.
Population of district	11,000. Number of houses connected to section of sewage works experimented with, 554; estimated population, 3,770.
Water supply per head of the population	Estimated at 10 gallons per day. Supplied by South Staffordshire Waterworks Co. Rain water is stored and used largely for domestic purposes.
Measured dry weather flow of sewage	Average 50,356 gallons per day.
Is any trade refuse taken into the sewers?	The sewage is purely domestic and there are very few water closets.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse?	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Yes, except from back yards.
Officer under whom the experiment has been conducted.	Frederick W. Mager, engineer and surveyor to the Council.
Name and qualification of chemist who has made the analyses.	George Reid, M.D., County Med. Off. of Health, Stafford.
(1) (a) What is the capacity in gallons of the open septic tank or tanks?	68,750 gallons.
(b) If there was more than one tank state whether they were worked in series or in parallel.	Two tanks worked in parallel.
(2) Were any observations made as to the filling up of septic tanks by deposit of sludge? If the sludge was removed from the septic tanks state how often this was done and, approximately what quantity of sludge was removed on each occasion.	Yes, there is at present date (21st March) a deposit of sludge 2 feet deep, equal to 164 cubic yards, but this resulted from the use of precipitants, the sludge so produced not being removed when the tanks were started to be worked as open septic tanks. There has been no appreciable increase of sludge since October, 1900. No sludge has been removed since 21st May, 1900.
(3) (a) What are the form, the area and depth of the filters?	Rectangular, 125 sq. yards in area, 4 ft. 4½ in. deep.
(b) State the nature and size of the filtering material?	Screened and washed coal, top layer 2 ft. 6 in. thick, to pass ⅛ in. screen; 2nd layer, 1 in. thick, to pass ¼ in screen, and retained in ⅛ in. screen, remainder small cobbles.
(c) Were the sides of the filters open or closed?	Closed. Brick walls and cement concrete floor.
(4) What was the rate of filtration in gallons per square yard per 24 hours?	140 gallons. This quantity is governed by the hydraulic capacity of the distributors (*see* 7).
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	No chokage has occurred, and the filtering material is perfectly clean and free from odour.
(5) What was the average quantity of sewage in gallons dealt with daily?	18,000 gallons. The filters are worked 10 hours per day only; the remainder of the tank effluent is treated on prepared land.
(6) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	Not as regards the filters.
(7) State by what method the tank liquor was distributed on the filters.	Plan and section are given. AA is a 3 in. cast iron pipe B.B. are 1¼ inch galvanised perforated tubes. The ends of the pipes are stoppered and there is a head of 12 in. from the open septic tanks. The sewage is by these means sprayed over the surface of the beds. I should not recommend this method in a very large installation as the labour necessary to keep the perforations clear would be considerable.

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(8) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.

Samples collected periodically. Samples of sewage, tank effluent, filter effluent, and mixed filter and land effluent on five occasions (excepting sewage 4 occasions) between May 1900 and February 1901. Analysed without filtration or subsidence.

(9) Give (*a*) the average of the analyses of the final effluent from the filters.

	After ordinary tank subsidence.	After septic tank treatment.
Ammoniacal nitrogen -	0·271	0·254
Albuminoid nitrogen -	0·040	0·044
Nitric nitrogen - -	1·320	1·000

(*b*) The best analysis and date when sample was taken, and

May 19th, 1900.

(*c*) The worst analysis and date when sample was taken.

February 4th, 1901.

	B	C.
Ammoniacal nitrogen - - -	0·297	0·252
Albuminoid nitrogen - - -	0·036	0·054
Nitric nitrogen - - - -	1·040	1·000

(*d*) The average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters.

Solids in suspension = 5·3.

(*e*) The average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?

Solids in suspension = 1·08.

(10) Give a typical analysis of the crude sewage to which the experiment relates.

Solids in solution - - - - -	81·2
„ „ suspension - - - - -	44·4
Total - - -	125·6
Chlorine - - - - - - -	8·1
Ammoniacal nitrogen - - -	1·639
Albuminoid nitrogen - - - -	0·999
Oxygen absorbed in 4 hours at 80° F. -	4·629
Nitric nitrogen - - - - -	0·00

(11) Between what dates was the experiment conducted?

If there were any periods of rest, state their duration.

The experiment was commenced on 11th October last and has been carried on continuously to the present date.

(12) Give particulars of any observations which have been made of the temperatures of the filters at different depths.

(13) Was any nuisance caused by the experimental works?

Practically no odour whatever has been observed since septic action became well established.

(14) Is the experiment still proceeding? - - - -

Yes.

If so, may the Commission inspect the works, should they deem it desirable to do so?

(15) Give particulars of any other observations of importance which have been recorded.

The sewage generally from the works is passed over prepared land and the effluent is mixed with that from the experimental filters in the outfall pipe. An analysis of this combined effluent is given below, and on comparison with that of the experimental filters it will be seen that the quality of the land effluent is much below that of the filtrate.

Ammoniacal nitrogen - - - -	·231
Albuminoid nitrogen - - - -	·107
Nitric nitrogen - - - - -	·872

(16) What inferences have been drawn from the experiment?

The experiment was commenced to ascertain whether chemical mixing apparatus and sludge pumping machinery, which would otherwise have had to be put down, might be dispensed with. The results both chemically and financially are such as justify the continuance of the works upon the foregoing lines.

(17) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) What would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.

At present price of materials and labour the cost per head would be 8*s*. to 10*s*.

(*b*) What would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.

2*d*. per head.

Note.– It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

FREDK W. MAGER, Engineer and Surveyor, Walsall Rural District Council.
Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form G.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK FOLLOWED BY CONTINUOUS FILTRATION.

Name of authority	Corporation of York.
Population of district	About 75,000.
Water supply per head of the population	33 gallons per day.
Estimated or measured dry weather flow of sewage	45 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Trade refuse so slight as to be negligible.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Storm water partially when it exceeds the capacity of the sewers or the power of the pumps, the latter being 6,000 gallons per minute. Soil and surface water, no.
Officer under whom the experiment has been conducted	City Engineer and Surveyor.
Name and qualification of chemist who has made the analyses.	(*a*) Thomas Fairley, F.I.C., F.R.S. Edin.; F.C.S. London, &c., &c. (*b*) Edmund Moody Smith, M.D., C.M. Edin.; D.P.H. Camb.; Medical Officer of Health, York.

(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	250,000.
(*b*) If there was more than one tank state whether they were worked in series or in parallel.	One tank only.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	It is tested from time to time by a glass tube, but only a very slight deposit of about 2 inches has been found.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	The supernatent water was drawn off on August 26th after 63 days' use, when the sludge was found to average 2 inches over the whole area of tank; this was removed. No sludge has been removed since. Three series of perforated pipes were laid in this filter from the circumference to within a few feet of the centre. The "bottom," consisting of 8 rows, was laid on the concrete floor. The second or "middle" series, also of 8 rows, was laid 2 ft. above the floor, the third or "top" series, also of 8 rows, laid at 4 ft. above the floor. The letters *a*, *b* and *c* refer in each case to the position in the filter where the temperature was taken— (*a*) is 3 ft. from the circumference. (*b*) is 13 ft. " " (*c*) is 29½ ft. " " The figures given in table at (12) are averages. If further temperatures are required they can be furnished, as we have a large number of observations.
(3) (*a*) What are the form, the area and depth of the filters?	Circular; 399 square yards; 6 ft. 9 in.
(*b*) State the nature and size of the filtering material.	From ½ inch to 2½ inches clinker and coke.
(*c*) Were the sides of the filters open or closed?	Open, built of pigeon-hole brickwork.
(4) What was the rate of filtration in gallons per square yard per 24 hours?	Commenced at 210 gallons, maximum 527 gallons (this is the largest quantity we could get to the filter); average over whole period 426 gallons per square yard per 24 hours.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	No. It has never been reduced in consequence of choking, or any other incident of working.
(5) What was the average quantity of sewage in gallons dealt with daily?	About 160,000 gallons.
(6) Was the quantity of sewage dealt with increased in time of storm?	No.
If so, state to what extent, and how the results were affected by such increase.	
(7) State by what method the tank liquor was distributed on the filters.	By perforated tubing revolving under a head of 6 inches.

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(8) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.

From July, 1900, to January 11th, 1901, 13 full analyses have been made, and 7 partial analyses to ascertain the free ammonia, albuminoid ammonia, nitrogen as calcium nitrate and oxygen (4 hours) only.

Samples were taken over from 4 to 12 hours, during the day, and allowed to clear before being analysed.

(9) Give (a) the average of the analyses of the final effluent from the filters;

Total solids	71·67
Mineral matter	64·41
Volatile and organic matter	7·06
Free ammonia	·115
Albuminoid ammonia	·072
Nitrogen as calcium nitrate	8·90
Nitrogen as nitrites	trace
Oxygen required to oxidise organic matter in 4 hours	·597
Reaction	alkaline
Chlorine	9·99
Sediment	trace
Containing organic matter	nil
Analysts	Mr. Fairley and Dr. Smith.

The analyses are of samples taken hourly over a period of 12 hours.

(b) the best analysis and date when sample was taken; and

(c) the worst analysis and date when sample was taken;

——	(b) Aug. 17th, 1900.	(c) Oct. 21st, 1900.
Total solids	70·71	79·9
Mineral matter	64·91	72·5
Volatile and organic matter	5·80	not stated
Free ammonia	·026	·30
Albuminoid ammonia	·044	·077
Nitrogen as calcium nitrate	11·14	11·30
do. as nitrites	trace	trace
Oxygen (4 hours)	·443	1·057
Reaction	alkaline	alkaline
*Smell	nil	nil
Chlorine	10·5	5·91
*Sediment	trace	—
*Containing organic matter	—	—
Analyst	Mr. Fairley.	Dr. Smith.

* These terms were introduced in connection with sewage analyses, and have little or no application to the effluent.

(d) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters;

Not ascertained.

(e) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?

Under 1 grain. No.

(10) Give a typical analysis of the crude sewage to which the experiment relates.

Total solids	89·04
Mineral matter	73·37
Volatile and organic matter	15·67
Free ammonia	3·92
Albuminoid ammonia	·54
Nitrogen as calcium nitrate	nil
Nitrogen as nitrites	nil
Oxygen required to oxidise organic matter in 4 hours	3·46
Reaction	alkaline
Smell (when cold)	offensive
Chlorine	14·61
Sediment	61·76
Containing organic matter	29·68
Analyst	Mr. Fairley.

(11) Between what dates was the experiment conducted?

July 5th, 1900, to date, and still in operation.

If there were any periods of rest, state their duration.

The periods of rest were necessitated to improve the spreader and to fill up the bed with clinker; the bed commenced work with only 4 ft. of medium and was filled up from time to time as we were able to accumulate material.

6 a.m. July 18th to 5.30 p.m. July 19th; noon Aug. 23rd to 10.30 a.m., Aug. 26th; 11 a.m., Sept. 11th, to 1 p.m., same day; 6 a.m. Oct. 16th to 10.30 a.m. Oct. 19th.

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(12) Give particulars of any observations which have been made of the temperatures of the filters at different depths. *See* 2.

Date, 1901.	Atmosphere.	Top.			Middle.			Bottom.			Effluent from Bed.
		a	*b*	*c*	*a*	*b*	*c*	*a*	*b*	*c*	
Jan. 9 -	23	41·4	41·9	43	39·7	40·7	42·4	–	–	–	42
„ 11 -	38·8	45·1	45·4	45·9	44·9	45·3	45·9	45·7	46·0	46·5	46
„ 15 -	32	41·0	42·8	46·4	38·1	41·9	42·9	40·4	42·9	44·0	40

Average for 7 days, January 9th to 15th, 1901.

—	Date, 1901.	Atmosphere.	Top.			Middle.			Bottom.			Effluent from Bed.
			a	*b*	*c*	*a*	*b*	*c*	*a*	*b*	*c*	
Average for 168 observations	Jan. 9 to 15	35·2	43·3	44·3	46·3	–	–	–	–	–	–	43·6
„ „ 168 „	„ „	35·1	–	–	–	42·7	44·1	45	–	–	–	43·6
„ „ 52 „	11 to 15	36·5	–	–	–	–	–	–	44·0	45·6	46·1	44

(13) Was any nuisance caused by the experimental works? — No.

(14) Is the experiment still proceeding? - - - - — Yes.

If so, may the Commission inspect the works, should they deem it desirable to do so? — Yes.

(15) Give particulars of any other observations of importance which have been recorded.

No scum has been formed on the surface of the open septic, except that formed from time to time of gas bubbles, and these have disappeared in a day or two.

In fine weather millions of small flies have been observed in the openings of the brick wall surrounding the filter, and numbers of very fine small red and white worms have come away from the filter in the effluent, during and after it has been standing for a few hours.

For some months after the filter was first brought into use a fine black and white ash was deposited in the surrounding channel, but this has latterly almost disappeared.

The absence of scum on the open septic would lead one to conclude that this tank is used as a subsidence tank only, but the absence of any large quantity of sludge on the bed of the tank shows clearly that septic action is taking place in the tank.

On opening down into the filter for a depth of 3 feet on the 1st February, 1901, I found at about 6 inches below the surface large quantities of the worms and flies referred to in the second paragraph.

(16) What inferences have been drawn from the experiment?

That this system is eminently suited for the treatment of our sewage; it gives uniformly excellent results, the effluent is in a high state of nitrification when it leaves the beds, and is discharged into a river not used for drinking purposes below the outlet. The river in the driest year for 25 years and with a rainfall of only 7 inches in the six months previous to the gauging showed a flow of 136 million gallons in 24 hours, while for 268 days of this dry year the flow was 165 million gallons a day or over.

A moveable screen on wheels to revolve around the filter would serve to protect it from very cold high winds which now go to reduce the temperature in the filter at that side from which the wind is blowing, if the filters were placed together in a nest, a wall surrounding the site would be beneficial in cold weather.

(17) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state—	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers;	About £25,000 = 6s. 8d. per head.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	About £400 = 1s. 8d. per head.

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

This cannot now be done ; the analyses are given as received. A standard form for sewage analyses is very much needed.

A. Creer.
Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form H.

EXPERIMENT ON THE TREATMENT OF SEWAGE BY CHEMICAL PRECIPITATION, SUBSIDENCE TANKS, AND CONTINUOUS FILTRATION. (COAL FILTER.)

Name of authority	Manchester.
Population of district	500,000.
Water supply per head of the population	gallons per day.
Estimated or measured dry weather flow of sewage	19,500,000 (about) gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived, and approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil, or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enter the sewers. Storm overflows are provided at certain points, which are supposed to come into action at a dilution of 5 to 1: in certain cases, however, they fail to answer their purpose.
Officer under whom the experiment has been conducted	Gilbert J. Fowler, M.Sc., F.I.C.
Name and qualification of chemist who has made the analyses.	H. D. Bell, A. C. Oddie, Junior assistants.
(1) What was the nature of the chemical or chemicals used?	Lime and copperas.
(2) What was the normal proportion of chemical or of chemicals (in grains per gallon) used?	CaO 6·28, $FeSO_4$ 7 HgO 6·04.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	
(4) What is the capacity in gallons of the subsidence tanks?	Eleven tanks. Total capacity, 12,375,000 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	3,000 tons per week. About once a week.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (*a*) What are the form, the area and depth of the filters?	Rectangular, 25 square yards, 3 ft. deep.
(*b*) State the nature and size of the filtering material.	Coal, 6 in. of large lumps at the bottom, 2 ft. 6 in. all sizes up to ½ in. (including dust). August 11th material taken out and dust washed out.
(*c*) Were the sides of the filters open or closed?	Closed.
(8) What was the rate of filtration in gallons per square yard per 24 hours?	960 gallons per square yard, per 24 hours.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	Yes, to 196 gallons per square yard per 24 hours.
(9) What was the average quantity of sewage in gallons dealt with daily?	Period I.—August 5–9, and August 11–29, 24,000 gallons per 24 hours. Period II.—August 30 to September 25, 10,300 gallons per 24 hours. Period III.—October 13 to November 17, 4,900 gallons per 24 hours.
(10) Was the quantity of sewage dealt with increased in time of storm?	No.
If so state to what extent, and how the results were affected by such increase.	

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(11) State by what method the tank liquor was distributed on the filters.	By means of wooden shoots laid on the surface of the bed.
(12) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.	Daily, except Sundays. Samples were shaken before analysis.
(13) Give (*a*) the average of the analyses of the final effluent from the filters.	

ANALYTICAL RESULTS—Parts per 100,000.

DATE.	Four Hours' Oxygen Absorption.	Incubation Test. Three Minutes Oxygen Absorption.		Ammoniacal Nitrogen.	Albuminoid Nitrogen.	REMARKS.
		Before.	After.			
1897 :						
Period I.						
5–9, 9–29 August - - -	4·06	3·69*	3·93	2·02	·20	No rest between dates mentioned. Filter worked continuously through 24 hours.
Period II.						
30 August to 25 September -	5·46	3·13	3·71	2·71	·247	Filter allowed to rest 12 hours during each night, and on Sundays.
Period III.						
13 October to 17 November -	4·37	2·77	3·20	2·46	·22	Filter allowed to rest 16 hours in 24. Also on Sundays.

* The figures for 3 minutes' oxygen absorption during this period refer to average from August 26th to 29th only.

(*b*) the best analysis and date when sample was taken ; and	
(*c*) the worst analysis and date when sample was taken ;	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters ;	About 5 to 6 parts per 100,000.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible ?	Fair amount. Yes.
(14) Give a typical analysis of the crude sewage to which the experiment relates.	The following numbers are the average of daily analyses of *Crude Sewage* from August 25th to December 29th, 1897 :— 4 hours' oxygen absorption - - - 10·86 3 minutes' oxygen absorption - - 4·94 Ammoniacal nitrogen - - - - 2·60 Albuminoid nitrogen - - - - ·66 Chlorine - - - - - - - - 15·4
(15) Between what dates was the experiment conducted ?	From August 5th to November 17th, 1897.
If there were any periods of rest, state their duration.	Periods of rest :—August 9th to 11th, during removal of dust by washing ; 12 hours each day from August 30th to September 25th, and on Sundays ; September 25th to October 13th, measurements of capacity, &c. ; 16 hours each day from October 13th to November 17th, and on Sundays.
(16) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	
(17) Was any nuisance caused by the experimental works ?	No.
(18) Is the experiment still proceeding ?	No.
If so, may the Commission inspect the works, should they deem it desirable to do so ?	
(19) Give particulars of any other observations of importance which have been recorded.	On August 11th the material of the bed was removed, and the fine dust washed out. On replacing the washed material, measurement showed that its water-holding capacity had considerably increased from its previous amount. It is probable that the fine material impeded the drainage of the bed.
(20) What inferences have been drawn from the experiment ?	Continuous filtration carried out in the above manner offers no advantage over intermittent treatment either as regards quantity dealt with, or quality of filtrate produced. Mere straining is quite ineffectual as a means of purification.

Appendix 9C.

(21) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state—

(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers;

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

GILBERT J. FOWLER.

Signature of Officer under whose direction the experiment was conducted.

Form H. Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE BY CHEMICAL PRECIPITATION, SUBSIDENCE TANKS, AND CONTINUOUS FILTRATION. BALLAST FILTER. (BURNT CLAY.

Name of authority	Manchester.
Population of district	500,000.
Water supply per head of the population	gallons per day.
Estimated or measured dry weather flow of sewage	19,500,000 (about) gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enter the sewers. Storm overflows are provided at certain points which are supposed to come into action at a dilution of 5 to 1; in certain cases, however they fail to answer their purpose.
Officer under whom the experiment has been conducted	Gilbert J. Fowler, M.Sc. (Vict.), F.I.C.
Name and qualification of chemist who has made the analyses.	H. D. Bell, A. C. Oddie, junior assistants.

(1) What was the nature of the chemical or chemicals used?	Lime and copperas.
(2) What was the normal proportion of chemical or of chemicals (in grains per gallon) used?	CaO 6·28; $FeSO_4\,7H_2O$ 6·04.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	
(4) What is the capacity in gallons of the subsidence tanks?	Eleven tanks. Total capacity 12,375,000.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	3,000 tons per week. About once a week.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (*a*) What are the form, the area and depth of the filter?	Rectangular; 25 square yards; 3 feet deep.
(*b*) State the nature and size of the filtering material	
(*c*) Were the sides of the filter open or closed?	Closed.
(8) What was the rate of filtration in gallons per square yard per 24 hours?	7,680 gallons per square yard per 24 hours.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	Yes, to 291 gallons per square yard per 24 hours.
(9) What was the average quantity of sewage in gallons dealt with daily?	Period I.—August 23–29, 192,000 gallons per 24 hours. Period II.—August 30–September 22, 82,300 gallons per 24 hours. Period III.—Sept. 23–25, 192,000 gallons per 24 hours. Period IV.—October 13–November 17, 7,275 gallons per 24 hours.
(10) Was the quantity of sewage dealt with increased in time of storm?	No.
If so, state to what extent, and how the results were affected by such increase.	
(11) State by what method the tank liquor was distributed on the filters.	By means of wooden shoots laid on the surface of the beds.
(12) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.	Daily except Sundays. Samples shaken before analyses.

Appendix 9C. (13) Give (*a*) the average of the analyses of the final effluent from the filters

ANALYTICAL RESULTS.—Parts per 100,000.

DATE.	Four Hours Oxygen Absorption.	Incubator Test. Three Minutes Oxygen Absorption.		Ammoniacal Nitrogen.	Albuminoid Nitrogen.	REMARKS.
		Before.	After.			
1897 :						
Period I.						
23–29 August - - - -	5·23	*3·83	4·53	2·17	·241	Filter kept always full by means of side pipe. Filtration continuous, no rest.
Period II.						
30 August to 22 September -	5·83	3·53	3·76	2·40	·282	Filter allowed to rest for 12 hours during the night, the side pipe being taken off to allow the bed to empty ; also rests on Sundays.
Period III.						
23–25 September - - -	6·79	4·01	4·60	3·00	·282	As in Period II., with the exception that the side pipe was not taken off during the period of rest, consequently the bed alwa remained full.
Period IV.						
13 October to 17 November -	5·51	3·31	3·84	2·34	·282	Filter resting 16 hours in 24. Bed kept full while working and emptied before resting.

* The numbers for 3 minutes oxygen absorption refer to average from 26 to 28 August, 1897.

(*b*) the best analysis and date when sample was taken ; and

(*c*) the worst analysis and date when sample was taken ;

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters ;

About 5 to 6 parts per 100,000.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible ?

Very fair amount. Yes.

(14) Give a typical analysis of the crude sewage to which the experiment relates.

The following numbers are the average of daily analyses of crude sewage from August 25th to December 29th, 1897 :—

4 hours oxygen absorption - - -	10·86
3 minutes oxygen absorption - - -	4·94
Ammoniacal nitrogen - - - -	2·60
Albuminoid nitrogen - - - -	·66
Chlorine - - - - - - -	15·4

(15) Between what dates was the experiment conducted ?

If there were any periods of rest, state their duration.

August 23rd to November 7th, 1897. 12 hours each day from August 30 to September 25th, and Sundays. September 26th to October 13th for measurements of capacity. 16 hours each day from October 13th to November 17th.

(16) Give particulars of any observations which have been made of the temperatures of the filters at different depths.

(17) Was any nuisance caused by the experimental works ?

No.

(18) Is the experiment still proceeding ?

If so, may the Commission inspect the works, should they deem it desirable to do so ?

No.

(19) Give particulars of any other observations of importance which have been recorded.

(20) What inferences have been drawn from the experiment ?

Continuous filtration carried out in the above manner offers no advantage over intermittent treatment. Mere straining is quite ineffectual as a means of purification.

(21) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers ;

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note 2.—The expression " subsidence tanks " is intended to denote tanks which are used so that little or no " septic " action is produced.

GILBERT J. FOWLER.
Signature of Officer under whose direction the experiment was conducted.

Form H. Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE BY CHEMICAL PRECIPITATION, SUBSIDENCE TANKS, AND CONTINUOUS FILTRATION. (WILSON FILTER.)

Name of authority	Manchester.
Population of district	400,000 to 500,000.
Water supply per head of the population	gallons per day.
Estimated or measured dry weather flow of sewage	gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Yes.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Mostly enters the sewers. Storm overflows are provided at certain points, which are supposed to come into action at a dilution of 5 to 1; in certain cases, however, they fail to answer their purpose.
Officer under whom the experiment has been conducted	Gilbert J. Fowler, M.Sc., F.I.C.
Name and qualification of chemist who has made the analyses.	H. D. Bell, A. C. Oddie, Junior Assistants.
(1) What was the nature of the chemical or chemicals used?	Lime and copperas.
(2) What was the normal proportion of chemical or of chemicals (in grains per gallon) used?	CaO 6·28, $FeSO_4 7, H_2O$ 6·04.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	
(4) What is the capacity in gallons of the subsidence tanks?	Eleven tanks. Total capacity 12,375,000.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	3,000 tons per week. About once a week.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (a) What are the form, the area and depth of the filters? (b) State the nature and size of the filtering material (c) Were the sides of the filters open or closed?	The filter consisted essentially of a layer of filtering medium about 6 in. thick (either coke, coal or sand), together with a flushing tank by means of which the medium was cleaned from time to time automatically by upward flush. The whole arrangement was constructed in ironwork.
(8) What was the rate of filtration in gallons per square yard per 24 hours? State whether the rate of filtration was reduced during the experiment, in consequence of the choking of the filters, and, if so, to what extent.	
(9) What was the average quantity of sewage in gallons dealt with daily?	84,816 gallons per day. The above includes, to the extent of 7½ per cent., water used for washing purposes.
(10) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	
(11) State by what method the tank liquor was distributed on the filters.	
(12) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.	Daily except Sundays.

Appendix 9C.

(13) Give (*a*) the average of the analyses of the final effluent from the filters;	
(*b*) the best analysis and date when sample was taken; and	
(*c*) the worst analysis and date when sample was taken;	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters;	3·9 parts per 100,000.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?	Nil.
(14) Give a typical analysis of the crude sewage to which the experiment relates.	
(15) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	December, 1896, to November 3rd, 1897.
(16) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	
(17) Was any nuisance caused by the experimental works?	No.
(18) Is the experiment still proceeding? If so, may the Commission inspect the works, should they deem it desirable to do so?	No.
(19) Give particulars of any other observations of importance which have been recorded.	In the earlier stages of the working of this filter the removal of suspended and putrescible matters was such as to render the filtrate in many cases non-putrefactive; at each washing, however, some residuum remained, and the filtrate soon ceased to be non-putrefactive. On taking the filter to pieces, a considerable amount of black putrescent matter was found in the filter and in the pipes leading to it.
(20) What inferences have been drawn from the experiment?	That such a filter as this, while having its possible uses as a roughing filter, is not suited for the final purification of sewage. In the removal of silt from river water or suspended matter from trade refuse, it would no doubt find useful application. The composition of the suspended matter removed from the effluent showed that a considerable amount of iron and lime from the treatment was passing away in the tank effluent and that therefore the addition of those chemicals must be limited in amount.
(21) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers;	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

GILBERT J. FOWLER.

Signature of Officer under whose direction the experiment was conducted.

Form H. Appendix 9C.

EXPERIMENT ON THE TREATMENT OF SEWAGE BY CHEMICAL PRECIPITATION, SUBSIDENCE TANKS, AND CONTINUOUS FILTRATION.

Name of authority - - - - - - - -	Ardsley Urban District Council.
Population of district (Ardsley and Stairfoot area) -	5,250.
Water supply per head of the population - - -	$10\frac{1}{2}$ to 11 gallons per day.
Estimated or measured dry weather flow of sewage -	55,000 gallons per day.
Is any trade refuse taken into the sewers?	No.
If so, state from what processes it is derived, and approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially.
Officer under whom the experiment has been conducted	The works are permanent, not experimental, and have been managed by a man under the Council's surveyor.
Name and qualification of chemist who has made the analyses.	*A.*—Dr. Wilson, of the West Riding Rivers Board. *B.*—J. Carter Bell, Cheshire County Analyst, &c.

(1) What was the nature of the chemical or chemicals used?	Alumino-ferric.
(2) What was the normal proportion of chemical or of chemicals (in grains per gallon) used?	No accurate account kept, probably about 10.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	Yes, roughly.
(4) What is the capacity in gallons of the subsidence tanks?	50,624.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	No account kept.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (*a*) What are the form, the area and depth of the filters?	About 200 square yards; four in number; filtering material 2 feet 6 inches deep, walls 18 inches higher.
(*b*) State the nature and size of the filtering material -	Gravel, sand and "polarite."
(*c*) Were the sides of the filters open or closed? -	Closed. Arranged for reversing flow for washing surface
(8) What was the rate of filtration in gallons per square yard per 24 hours?	Capable of any speed up to 800 gallons per yard per 24 hours.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	Yes, say to less than 100 gallons per yard. Surface only choked and required washing every few days.
(9) What was the average quantity of sewage in gallons dealt with daily?	Probably 100,000 gallons.
(10) Was the quantity of sewage dealt with increased in time of storm?	Yes.
If so, state to what extent, and how the results were affected by such increase.	In tanks, treated till diluted with storm water 6 times; in filters 3 times dilution.
(11) State by what method the tank liquor was distributed on the filters.	Allowed to flow on to a long channel, level with the surface of material. Each filter allowed some hours rest daily.
(12) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.	The Council only had one analysis made. The Rivers Board take samples at irregular intervals, the following being one of those supplied by them, being one of many.

Appendix 9C.

(13) Give (*a*) the average of the analyses of the final effluent from the filters.

(*b*) the best analysis and date when sample was taken, and

(*c*) the worst analysis and date when sample was taken;

(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters;

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?

Dr. Wilson's Report.

5th September, 1899. Filter effluent.

Slightly turbid.
Sediment, very small yellow.
Odour, slightly earthy.
Reaction, neutral.

	parts per 100,000.
Chlorides equal to sodium chloride - -	13·16
Oxygen absorbed in 4 hours at 80° Fahr. -	0·65

(14) Give a typical analysis of the crude sewage to which the experiment relates.

Mr. Bell's Report—Filter effluent.

30th March, 1897.

	Grains per gallon.
Total solids at 212° F. - - - - -	74·0
Mineral solids - - - - - -	59·0
Loss on ignition - - - - -	15·0
Chlorine - - - - - -	4·8
Free ammonia - - - - - -	1·1
Albuminoid ammonia - - - -	·11
Oxygen required for 15 minutes - -	·16
" " 3 hours - -	·30

This is a first class clear effluent and fit to run into any stream or river.

(15) Between what dates was the experiment conducted?

The works have been in continuous operation since June 1896.

If there were any periods of rest, state their duration.

(16) Give particulars of any observations which have been made of the temperatures of the filters at different depths.

None made.

(17) Was any nuisance caused by the experimental works?

No nuisance

(18) Is the experiment still proceeding?

If so, may the Commission inspect the works, should they deem it desirable to do so?

The works are in regular operation, and the Commission may visit with or without prior notice.

(19) Give particulars of any other observations of importance which have been recorded.

Although the works give the Rivers Board general satisfaction, the Local Government Board have required the District Council to run the effluent over the available land, this land; is about to be prepared for the purpose.

(20) What inferences have been drawn from the experiment?

It is possible that in the near future the works will be converted into an efficient bacteria system, a method for which the construction of tanks and filters could easily be adapted, the object being to save expense of chemicals and reduce quantity of sludge.

(21) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state—

(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.

The actual total cost of outfall works was about £2,300.

(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.

No reliable data available.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

Theo. S. McCallum, A.M.Inst.C.E.
Engineer for the Works.

Signature of Officer under whose direction the experiment was conducted.

20th February, 1901

Form H.

Appendix 9C

EXPERIMENT ON THE TREATMENT OF SEWAGE BY CHEMICAL PRECIPITATION, SUBSIDENCE TANKS, AND CONTINUOUS FILTRATION.

Name of authority - - - - - - - -	Birkenshaw Urban District Council.
Population of district - - - - - - - -	About 2,500.
Water supply per head of the population - - -	About nine gallons per day.
Estimated or measured dry weather flow of sewage -	Estimated at 107,460 gallons per day.
Is any trade refuse taken into the sewers? - - -	No.
If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted.	The Surveyor of the Council.
Name and qualification of chemist who has made the analyses.	The inspectors of the West Riding of Yorkshire Rivers Board, and the officers of that Board.
(1) What was the nature of the chemical or chemicals used?	Alumino-ferric.
(2) What was the normal proportion of chemical or of chemicals (in grains per gallon) used?	One cake per day, or about 12 tons per annum.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	The chemicals were decreased when there was a large flow of storm water.
(4) What is the capacity in gallons of the subsidence tanks?	383,465.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	About five tons once a week.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Intermittent.
(7) (*a*) What are the form, the area and depth of the filters?	No. 1 filter bed, 50 feet × 40 × 4 feet 6 inches deep. No. 2 filter bed, 36 feet × 25 × 5 feet deep.
(*b*) State the nature and size of the filtering material	One foot of broken stone, $1\frac{1}{4}$ foot broken clinker, 1 foot of breeze, 1 foot small stone, and 6 inches sand.
(*c*) Were the sides of the filters open or closed?	Open.
(8) What was the rate of filtration in gallons per square yard per 24 hours?	
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	
9) What was the average quantity of sewage in gallons dealt with daily?	
(10) Was the quantity of sewage dealt with increased in time of storm?	Yes.
If so, state to what extent, and how the results were affected by such increase.	In some cases from 2 to 3 tons of grit come down into outfall works, but not into the tanks.
(11) State by what method the tank liquor was distributed on the filters.	From wood floating arm into 6 inches iron pipe with valve.
(12) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.	No analyst employed by the Council. The Rivers Board before-mentioned could answer this and following queries up to and inclusive of No. 16.
(13) Give (*a*) the average of the analyses of the final effluent from the filters.	
(*b*) the best analysis and date when sample was taken, and	
(*c*) the worst analysis and date when sample was taken,	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters.	
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?	

Appendix 9C.

(14) Give a typical analysis of the crude sewage to which the experiment relates.	
(15) Between what dates was the experiment conducted?	
If there were any periods of rest, state their duration.	
(16) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	
(17) Was any nuisance caused by the experimental works?	No.
(18) Is the experiment still proceeding?	
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes, with pleasure
(19) Give particulars of any other observations of importance which have been recorded.	
(20) What inferences have been drawn from the experiment?	The works are satisfactory
(21) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state—	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal excluding the cost of land and cost of sewers.	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

EDWIN WALTER SMITH (Surveyor),
Signature of Officer under whose direction
the experiment was conducted.

Form H.

Appendix 9C

EXPERIMENT ON THE TREATMENT OF SEWAGE BY CONTINUOUS FILTRATION, AFTER CHEMICAL PRECIPITATION.

Name of authority	Buxton.
Population of district	Season 20,000 ; resident 10,000.
Water supply per head of the population	About 50 gallons per day.
Estimated or measured dry weather flow of sewage	One million gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse?	No.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially.
Officer under whom the experiment has been conducted	Wm. Hedley Grieves, Town Surveyor.
Name and qualification of chemist who has made the analyses.	Mr. R. Wright, F.C.S., Examiner to the Pharmaceutical Society of Great Britain, chemist, Buxton, also Dr. Barwise, County Medical Officer of Health, Derby, and Dr. J. C. Thresh, County Medical Officer of Health, Chelmsford.

(1) (*a*) What are the form, the area and depth of the filters?

(*a*)

Description.	Dimensions.	Area.	Depth.
	ft. ins. ft. ins.	sq. ft.	ft. ins.
Coke breeze	19 0 by 6 5	126	3 1
Destructor breeze	19 7 ,, 9 1	180	3 1
Coal filter	19 0 ,, 6 2	115	4 0

(*b*) State the nature and size of the filtering material

(*b*)
Coke Breeze :—In the bottom 4-inch land drain tiles are laid, herring bone fashion, covered with—

- 2-inch layer of 2-inch limestone.
- 2-foot ,, screened coke breeze.
- 2-inch ,, 2-inch limestone.
- 1-inch ,, limestone chippings, ¼ inch.
- 4-inch ,, screened coke breeze.

Destructor Breeze Filter :—4-inch land drain tiles as above, covered with—

- 2-inch layer of 2-inch limestone.
- 2-foot ,, screened destructor breeze.
- 2-inch ,, 2-inch limestone.
- 1-inch ,, limestone chippings.
- 4-inch ,, screened destructor breeze.

Coal Filter :—Land drain tiles as above, covered with—

- 3-inch layer of coal to pass ½-inch mesh.
- 1-inch ,, ,, stop at $\frac{3}{16}$-inch mesh.
- 2-inch ,, ,, ,, ⅜-inch mesh.
- 2-foot screened destructor breeze.
- 5-inch layer of coal to pass ¼-inch mesh.
- 6-inch ,, ,, ,, ⅛-inch mesh.
- 4-inch clean sharp sand.

(*c*) Were the sides of the filters open or closed? — Closed.

(2) What was the rate of filtration in gallons per square yard per 24 hours?

	Maximum.	Minimum.
Coal	1,032	780
Destructor	2,000	719
Coke	1,347	500

State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.

In the case of the coal filter the rate of filtration was reduced by choking, but I think this is probably due to the very fine mesh of the coal, in the other filters choking did not appear to take place to any very great extent.

(3) What was the average quantity of sewage in gallons dealt with daily?

About 30,000 gallons.
N.B.—The filters were only working for 12 hours daily.

(4) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.

On the filters, no ; practically the same flow, regulated by gauges.

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(5) State by what method the tank liquor was distributed on the filters.

A portion of the precipitation tank effluent is conveyed direct to the filters by means of a wooden trough, 40 feet long, into a feed channel 11 feet long, from which there are three outlets on to the respective filters, each controlled by a sluice and fitted with a gauge. There is a layer of clean sharp sand on the top of the filtering material which is regularly raked and which ensures the even distribution of the effluent over the surface of the filters.

(6) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.

	No. of Analyses.		No. of Analyses.
January 1897 -	1	December 1897 -	2
February 1897 -	2	October 1898 -	1
March 1897 -	3	November 1898 -	1
April 1897 -	1	December 1898 -	1
June 1897 - -	1	March 1899 -	1
October 1897 -	1		

(7) Give (*a*) the average of the analyses of the final effluent from the filters.

Quantities stated in parts per 100,000.

	Oxygen Absorbed.	Free and Saline Ammonia.	Alluminoid Ammonia.	Nitrogen as Nitrates.
Average of Mr. Wright's analyses:				
Destructor filter - - - - -	1·2943	·3995	·070757	—
Coke filter - - - - - -	·838	·4677	·07064	—
Coal filter (one analysis only) -	·26	·60	·0670	—
Average of Dr. Barwise's analyses:				
Destructor filter - - - - -	—	·41	·0604	·32
Coke filter - - - - - -	—	·39	·0576	·3366
Coal filter - - - - - -	---	·56	·039	·566

(*b*) the best analysis and date when sample was taken, and

·02 parts per 100,000 of albuminoid ammonia from the coal filter on 16th November 1898.

(*c*) the worst analysis and date when sample was taken.

·157 parts per 100,000 of albuminoid ammonia from the destructor filter on 5th December 1897.

(*d*) One estimation made of the solids in suspension in the tank liquor as it went on to the filters.

Dr. Thresh's analysis. Raw sewage, 27·6 grains per gallon. Tank effluent, 5·3 grains per gallon (one analysis only).

(*e*) One estimation made of the solids in suspension in the final effluent. Were these solids putrescible?

Dr. Thresh's analysis. 3·0 grains per gallon not putrescible from the coke filter.

(8) Give a typical analysis of the crude sewage to which the experiment relates.

Quantities in parts per 100,000. Chlorine, 2·1. Free and saline ammonia, 1·05. Albuminoid ammonia, ·291.

(9) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.

January 1897 to present date. The filters have only worked 12 hours per day, resting during the night. When the filtrate has shown signs that the purification was not going on satisfactorily, the filters have been allowed to rest for periods ranging from a week to a month at a time.

(10) Give particulars of any observations which have been made of the temperatures of the filters at different depths.

(*See* answer to No. 13.)

(11) Was any nuisance caused by the experimental works?

None whatever.

(12) Is the experiment still proceeding?

Yes.

If so, may the Commission inspect the works, should they deem it desirable to do so.

Yes, certainly.

(13) Give particulars of any other observations of importance which have been recorded.

After four years' working the filtering medium has not required renewing in any filter. The filters are not materially affected by cold weather and even when frozen during the night's rest the temperature of the sewage is such that in a short time the filters work as though they had never been frozen. The Council are so satisfied with the result of the experiments that they have decided to construct filter beds to deal with the whole of the tank effluent, and for that purpose have secured three acres of land three-quarters of a mile below the present works, and plans are now being prepared for the same. The Local Government Board have sanctioned the borrowing of the money for the land

(14) What inferences have been drawn from the experiment?	1st. Continuously working the filters day and night causes them to become clogged and also causes a falling off of purification in the analytical results. 2nd. By working the filters intermittently, *i.e.*, by working during the day and resting during the night, with an occasional week's rest, say every three months, the result is a much more regular and a clearer effluent. 3rd. Owing to the fact that Buxton sewage is very weak, I have no hesitation in saying that 500 gallons per day can be safely treated per square yard of filter.
(15) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state—	Approximate estimate for filters, 6,000*l*.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	£5 per head of population, including pipe line from present works, but exclusive of site. *Note.*—Population taken as 12,000, which includes Fairfiels Urban district, whose sewage we treat.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	About 1*s*. per head.

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

W. H. Grieves,
Signature of Officer under whose direction
the experiment was conducted.

Appendix 9C. Form H.

THE TREATMENT OF SEWAGE BY CHEMICAL PRECIPITATION, SUBSIDENCE TANKS, AND CONTINUOUS FILTRATION.

Name of authority	Borough of Chorley.
Population of district	26,000.
Water supply per head of the population	19¼ gallons per day
Estimated or measured dry weather flow of sewage	600,000 to 700,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse:	Very little. From three breweries and one tannery. Blood from abattoirs. Cannot tell percentage.
Is the storm, soil or surface water, wholly or partially excluded from the ordinary sewers?	No.
Officer under whom the treatment has been conducted	Alderman H. F. Hibbert, J.P., C.C.
Name and qualification of chemist who has made the analyses	W. Naylor, F.I.C., F.C.S., Chief Inspector of the Ribble Watershed Committee.

(1) What was the nature of the chemical or chemicals used?	Ferrozone, ferral, and alumino-ferric.
(2) What was the normal proportion of chemical or of chemicals (in grains per gallon) used?	8·31.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	They vary every day, the highest being 11·2, the lowest 6·56.
(4) What is the capacity in gallons of the subsidence tanks?	1,442,800.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	526 tons per week of sludge containing 90 per cent. of water. The sludge was removed after every second filling.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Intermittent.
(7) (*a*) What are the form, the area and depth of the filters?	Rectangular; 1,388 superficial yards; 3 feet 3 inches deep.
(*b*) State the nature and size of the filtering material.	Top layer is sand from Fleetwood Harbour, then 12 inches of polarite and sand mixed, pea and bean gravel, and then graded from two to three inches boulder stones.
(*c*) Were the sides of the filters open or closed?	Closed.
(8) What was the rate of filtration in gallons per square yard per 24 hours?	450 gallons.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	The above filters are washed weekly, and filter more rapidly the first day after washing than the following days.
(9) What was the average quantity of sewage in gallons dealt with daily?	About 700,000.
(10) Was the quantity of sewage dealt with increased in time of storm?	Yes.
If so, state to what extent, and how the results were affected by such increase.	The daily flow increased in case of storms, three to four times the normal flow. In such a case as much as would go through the works would be treated. The remainder would go into the river untreated.
(11) State by what method the tank liquor was distributed on the filters.	By means of syphons. The syphons unseal every 40 minutes, day and night, and cover the filters about three inches deep. The capacity of the syphon chamber is 2,500 gallons; this quantity of water is therefore sent through the filters every 40 minutes. There is thus a layer of air between each filtration or passage of the water through the filters, which undoubtedly purifies the interior strata of the filters.
(12) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.	Samples examined as drawn, after shaking bottles.

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(13) Give (*a*) the average of the analyses of the final effluent from the filters;	·058 albuminoid nitrogen.
(*b*) the best analysis and date when sample was taken; and	·022 November, 1900.
(*c*) the worst analysis and date when sample was taken;	·088 February, 1900. The excessive impurity in this sample (*c*) was found to have been caused by a leakage in the pipe conveying the sand wash water from the filters to the sand wash water tank.
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters;	Two to three parts per 100,000.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?	Nil.
(14) Give an average analysis of the crude sewage to which the treatment relates.	Per 100,000. Albuminoid nitrogen - - - - ·66 Dissolved solids, about - - - 80·00 Suspended solids, from - - - 10·00 to 25·00 Chlorine - - - - - - - 9·00 The crude sewage is constantly varying owing to the conversion from pail to water carriage system which is now going on. This variation is caused by the emptying of the pails into the sewer. I have known the crude sewage to contain 5·0 per 100,000 albuminoid nitrogen.
(15) Between what dates was the treatment conducted? If there were any periods of rest state their duration.	From October 1895 to date.
(16) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	Have not made any.
(17) Was any nuisance caused by the treatment works?	No.
(18) Is the treatment still proceeding?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	The Commission have inspected the works.
(19) Give particulars of any other observations of importance which have been recorded.	I have experimented with continuous and quiescent flow on precipitation tanks, and have come to the conclusion that it is impossible, with continuous flow, to get as good results as from quiescent flow, either in quantity of water treated, or quality of the final effluent, if the said effluent has to be filtered through any filter which has a top stratum of sand. I have also made exhaustive experiments on continuous and intermittent flow on filters composed of sand, polarite, and gravel, the results of which prove that a water-logged filter will not produce satisfactory results, either in point of quantity or quality. I have also experimented with coke filters, on the same lines as the above, with the same results.
(20) What inferences have been drawn from the treatment?	I have visited all the principal sewage works in Lancashire, and am conversant with the different methods there in operation for the treatment of sewage, and as a result believe it is possible to treat sewage effectively by other systems than the one in operation at Chorley. I think, however, that none of them can produce an effluent as good as Chorley, in point of quantity, and quality of gallons treated, for the same expenditure, capital and current, in consequence of the greatly increased area of the filters.
(21) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state—	This system has been in operation since October 1895.
(*a*) what is the actual capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	The works have cost 14*s.* 7*d.* per head of the population (26,000) (£19,000).
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	Annual expenditure £1,373 9*s.* = 1*s.* 0½*d.* per head; but including the payment of interest and sinking fund the total charge per head of the population is 1*s.* 9¾*d.*

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

HENRY F. HIBBERT.

Signature of Officer under whose direction the treatment was conducted.

Appendix 9C.

Form H.

EXPERIMENT ON THE TREATMENT OF SEWAGE BY CHEMICAL PRECIPITATION, SUBSIDENCE TANKS, AND CONTINUOUS FILTRATION.

Name of authority - - - - - - - -	Littleborough.
Population of district - - - - - - -	10,878 (1891).
Water supply per head of the population - - -	15 gallons per day.
Estimated or measured dry weather flow of sewage- -	160,000 to 200,000 gallons per day.
Is any trade refuse taken into the sewers? - - - - If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	From one works only, known as flannelette finishing, about 7,000 gallons per day.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially excluded.
Officer under whom the experiment has been conducted.	No experiments as such.
Name and qualification of chemist who has made the analyses.	
(1) What was the nature of the chemical or chemicals used?	Alumino-ferric.
(2) What was the normal proportion of chemical or of chemicals (in grains per gallon) used?	Five grains per gallon.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	The same ratio.
(4) What is the capacity in gallons of the subsidence tanks?	320,000.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	Pressed sludge for 1900, 516 tons, containing about 55 per cent. of moisture.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Intermittent generally; may be and are occasionally used continuous.
(7) (a) What are the form, the area, and depth of the filters?	300 square yards area; square; and 2 ft. 6 in. deep.
(b) State the nature and size of the filtering material.	6 in. broken stone, size 2 in., in the bottom, then 6 in. of clinkers, 8 in. of cinders, size 1 in. to 1½ in., and 10 in. of fine cinders or engine ashes.
(c) Were the sides of the filters open or closed? -	Closed (filters ventilated).
(8) What was the rate of filtration in gallons per square yard per 24 hours?	800 to 900 gallons per square yard.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent?	Work regularly for some 7 years.
(9) What was the average quantity of sewage in gallons dealt with daily?	About 180,000.
(10) Was the quantity of sewage dealt with increased in time of storm?	Yes, more than double occasionally.
If so, state to what extent, and how the results were affected by such increase.	
(11) State by what method the tank liquor was distributed on the filters.	Floating arms from tanks and over wood troughs on to the filters.
(12) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.	Analysis left to Mersey and Irwell Committee.

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(13) Give (*a*) the average of the analyses of the final effluent from the filters :	23 samples. Oxidizable organic matter—oxygen absorbed, 4 hours : grains per gallon, 0·287.
(*b*) the best analysis and date when sample was taken ; and	January 29th, 1896, 0·07.
(*c*) the worst analysis and date when sample was taken ;	September 27th, 1899, 1·03, next worst July 23rd, 1900 0·57.
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters ;	No observations.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible ?	No observations.
(14) Give a typical analysis of the crude sewage to which the experiment relates.	No observations.
(15) Between what dates was the experiment conducted? If there were any periods of rest, state their duration.	o experiments.
(16) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	No experiments.
(17) Was any nuisance caused by the experimental works ?	No experiments.
(18) Is the experiment still proceeding ? If so, may the Commission inspect the works, should they deem it desirable to do so ?	No experiments.
(19) Give particulars of any other observations of importance which have been recorded.	
(20) What inferences have been drawn from the experiment ?	
(21) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers ;	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

George H. Wild
Signature of Officer under whose direction the works are conducted.

Appendix C9. Form H.

EXPERIMENT ON THE TREATMENT OF SEWAGE BY CHEMICAL PRECIPITATION, SUBSIDENCE TANKS, AND CONTINUOUS FILTRATION.

Name of authority	Normanton Urban District Council.
Population of district	Last census, 10,234. Estimated to March 1899, 13,310.
Water supply per head of the population	13 gallons per day. Total 175,000 gallons per day.
Estimated or measured dry weather flow of sewage	Estimated 135,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	No.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	No.
Officer under whom the experiment has been conducted	No experiment made beyond the ordinary daily process of treating the sewage.
Name and qualification of chemist who has made the analyses.	None made by Council, but Rivers Board have done so. Council are not aware of results of analysis.
(1) What was the nature of the chemical or chemicals used?	Alumino-ferric is used as a precipitant at the sewage works.
(2) What was the normal proportion of chemical or of chemicals (in grains per gallon) used?	No analysis made by Council, but 14 cwts. of alumino-ferric are used weekly in the sewage treatment.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	*See* answer to No. 2.
(4) What is the capacity in gallons of the subsidence tanks?	75,000 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	18,000 gallons. Weekly.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (*a*) What are the form, the area and depth of the filters?	Square ; 160 sq. yds. ; 3 ft. 3 in
(*b*) State the nature and size of the filtering material.	12 inches of gravel, from 2 inches to pea size. 12 inches of polarite and sand, and 15 inches of sand.
(*c*) Were the sides of the filters open or closed?	Closed.
(8) What was the rate of filtration in gallons per square yard per 24 hours?	Quantity not measured.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	Care is taken that the filters do not choke.
(9) What was the average quantity of sewage in gallons dealt with daily?	135,000 gallons.
(10) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	Naturally it increases, but to what extent I cannot say.
(11) State by what method the tank liquor was distributed on the filters.	By gravitation in open channels.
(12) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.	No analysis made by Council, but by Rivers Board. Council have no results.
(13) Give (*a*) the average of the analyses of the final effluent from the filters.	*See* answer to No. 12.
(*b*) the best analysis and date when sample was taken, and	
(*c*) the worst analysis and date when sample was taken,	*See* answer to No. 12.
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters.	*See* answer to No. 12.

(e) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?	*See* answer to No. 12.
(14) Give a typical analysis of the crude sewage to which the experiment relates.	*See* answer to No. 12.
(15) Between what dates was the experiment conducted?	
If there were any periods of rest, state their duration.	*See* answer to No. 12.
(16) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	No observations made.
(17) Was any nuisance caused by the experimental works?	No complaint has been made to the Council, and the Rivers Board seem satisfied.
(18) Is the experiment still proceeding?	The Commissioners may inspect the sewage works at any time on giving reasonable notice.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(19) Give particulars of any other observations of importance which have been recorded.	None.
(20) What inferences have been drawn from the experiment?	The effluent appears to be satisfactory.
(21) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	The system has been adopted, and is at present satisfactory to the West Riding Rivers Board.
(a) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	
(b) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

J. Eaton,
Sanitary Inspector.

Appendix 9C.

Form H.

EXPERIMENT ON THE TREATMENT OF SEWAGE BY CHEMICAL PRECIPITATION SUBSIDENCE TANKS, AND CONTINUOUS FILTRATION.

Name of authority	Royton Urban District Council.
Population of district	15,600 (present estimated).
Water supply per head of the population	
Estimated or measured dry weather flow of sewage	About 400,000 gallons per day.
Is any trade refuse taken into the sewers? If so, state from what process it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	No.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Only partially excluded.
Officer under whom the experiment has been conducted	Manager of the sewage works, Mr. David Wolstencroft.
Name and qualification of chemist who has made the analyses.	Wm. Naylor, Chief Inspector to the River Ribble Joint Committee. Also by Frank Scudder, F.I.C., for Sir Henry Roscoe.
(1) What was the nature of the chemical or chemicals used?	When experiments were made "Ferozone" was the precipitant used. For several years however alumino-ferric has been used, and it is considered more satisfactory and less variable in quality.
(2) What was the normal proportion of chemical or chemicals (in grains per gallon) used?	5·90 grains per gallon (average for a year).
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	Yes, we have an automatic mixer whereby the amount of precipitant used varies according to the flow of sewage.
(4) What is the capacity in gallons of the subsidence tanks?	6 tanks, 90,000 gallons each, or a total of 540,000 gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	36·65 tons of compressed sludge cake (weight after compression) removed from tanks into sludge pit every alternate day ready for being pumped into presses.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Intermittent.
(7) (*a*) What are the form, and area and depth of the filters?	20 yards × 5 yards each and 3 ft. deep. We have 8 filters ∴ total superficial area = 800 superficial yards.
(*b*) State the nature and size of the filtering material	The "International" Polarite Filter, viz., 9 in. sand; 9 in. polarite and sand, mixed in proportion 6 in. polarite to 3 in. sand; 2 in. fine sand; 3 in. pea gravel; 6 in. walnut size gravel; 7 in. bolder size.
(*c*) Were the sides of the filters open or closed?	Sides are closed, but 3 in. ventilating pipes are built in every two feet.
(8) What was the rate of filtration in gallons per square yard per 24 hours?	During an experiment lasting 2 hours and 6 minutes, effluent was filtered at a rate of 2,688 gallons per superficial yard per 24 hours.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	No.
(9) What was the average quantity of sewage in gallons dealt with daily?	425,000 gallons (average daily flow for last 12 months).
(10) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	Yes. The normal flow would sometimes be trebled. Improved purification on account of greater dilution.
(11) State by what method the tank liquor was distributed on the filters.	By centre and side distributing channels above the surface of the filters.

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(12) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.	Samples are taken frequently but at irregular intervals and at surprise visits paid by the inspectors of the Mersey and Irwell Joint Committee. They are afterwards analysed by or on behalf of Sir H. E. Roscoe, the analyst for the Joint Committee.
(13) Give (*a*) the average of the analyses of the final effluent from the filters;	Oxidisable organic matter. Oxygen absorbed 4 hours test, K_2MnO_4 solution. Average of the 10 last reports received from analyst to Mersey and Irwell Joint Committee ·49 grains per gallon.
(*b*) the best analysis and date when sample was taken; and	·13 grain per gallon. 4th December, 1895.
(*c*) the worst analysis and date when sample was taken;	1·36 grains per gallon. 15th July, 1898.
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters;	Cannot say.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?	Not been estimated.
(14) Give a typical analysis of the crude sewage to which the experiment relates.	In parts per 100,000.

Date.	Free. Ammonia.	Albuminoid Ammonia.	Oxygen absorbed in 4 hours.	Albuminoid Ammonia percentage of Purification.
1897				
27 April -	2·108	·384	3·5	80·2
29 April -	2·598	·602	1·7	80·9
4 May -	4·284	·818	7·3	91·7

(15) Between what dates was the experiment conducted? If there were any periods of rest state their duration.	The above experiments were made from April to May 1897. We have not had experiments carried out since. (*See* enclosed report.)
(16) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	Nil.
(17) Was any nuisance caused by the experimental works?	No.
(18) Is the experiment still proceeding?	No.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes, certainly.
(19) Give particulars of any other observations of importance which have been recorded.	Nil.
(20) What inferences have been drawn from the experiment?	The works have been in operation since 1894 and continue to give successful results.
(21) If it is considered that it would be practicable to adopt this system for the whole of the sewage of the district, please state	It is adopted for the whole district.
(*a*) What would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	Difficult to give, as the sewage works comprise tanks and filters, filtration plots, sewage-pressing machinery, refuse destructors.
(*b*) What would be the estimated annual cost per head, of purifying the sewage by this system, excluding the annual repayment of any loan.	About 1*s.* 5*d.* per head per annum.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

THOS. BLEASDALE,
Clerk and Surveyer to Council.
Signature of Officer under whose direction the experiment was conducted.

Appendix 9C.

Form H.

EXPERIMENT ON THE TREATMENT OF SEWAGE BY CHEMICAL PRECIPITATION, SUBSIDENCE TANKS, AND CONTINUOUS FILTRATION.

Name of authority	Walsall.
Population of district	Estimated 85,000.
Water supply per head of the population	35 gallons per day.
Estimated or measured dry weather flow of sewage	3,000,000 gallons per day.
Is any trade refuse taken into the sewers?	Yes.
If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	Curriers' tan pits, &c. Acids used in cleaning hardware goods.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	The Corporation have a surface water scheme in progress, part of which is laid—£3,000 out of £25,000.
Officer under whom the experiment has been conducted.	Borough Surveyor.
Name and qualification of chemist who has made the analyses.	E. W. T. Jones, F.I.C., borough analyst.
(1) What was the nature of the chemical or chemicals used?	Ferrous sulphate and lime.
(2) What was the normal proportion of chemical or of chemicals (in grains per gallon) used?	15 grains of iron.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give particulars of any such variations.	Chemicals are varied according to the sewage; at times no iron is required.
(4) What is the capacity in gallons of the subsidence tanks?	Two precipitation tanks each of about half a million gallons.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	Average (every ten days removal) amounting to 890 cubic yards or 623 cubic yards per week.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(7) (*a*) What are the form, the area and depth of the filters?	Two filters 87 ft. 0 in. × 27 ft. 0 in. × 2 ft. 8 in. deep.
(*b*) State the nature and size of the filtering material.	Polarite and sand with fine and coarse stone beneath.
(*c*) Were the sides of the filters open or closed?	Six ventilators in each bed; they go into body of filter.
(8) What was the rate of filtration in gallons per square yard per 24 hours?	400 gallons.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	If the surface is not cleaned the filters soon choke, and 1 inch of sand has then to taken off and replaced with clean. The rate of flow, if not kept clean, will be reduced quite one-half.
(9) What was the average quantity of sewage in gallons dealt with daily?	Only two experimental filters down, and for the best results 400 gallons per square yard of filter should not be exceeded per 24 hours.
(10) Was the quantity of sewage dealt with increased in time of storm?	No.
If so, state to what extent, and how the results were affected by such increase.	No.
(11) State by what method the tank liquor was distributed on the filters.	One central distributing trough full length of filter.
(12) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.	From January 9th 1897 to April 26th 1895. 13 samples analysed. Shaken before being analysed.
(13) Give (*a*) the average of the analyses of the final effluent from the filters;	Grains per gallon. Total solid matter - 64·57 Free ammonia - ·734 Organic ammonia - ·041 Nitrates - ·87 Chlorine - 6·56 Oxygen absorbed 80 - ·347

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Question	Answer
(b) the best analysis and date when sample was taken; and	20th February 1897: Solids 68·60; Free NH_3 ·434; Alb. NH_3 ·024; Nitrates 1·00; Chlorine 5·25; Oxygen absorbed ·247
(c) the worst analysis and date when sample was taken;	21st September, 1897: Solids 72·80; Free NH_3 1·092; Alb. NH_3 ·076; Nitrates ·63; Chlorine 11·48; Oxygen absorbed ·490

Date	Solids.	Free NH_3	Alb. NH_3	Nitrates.	Chlorine.	Oxygen absorbed.
20th February 1897:	68·60	·434	·024	1·00	5·25	·247
21st September, 1897:	72·80	1·092	·076	·63	11·48	·490

(d) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters; — None made.

(e) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible? — None made.

(14) Give a typical analysis of the crude sewage to which the experiment relates.

Grains per gallon.

Total solids - - - - - -	211·12
Solids in solution - - - - - -	134·40
Solids in suspension - - - -	76·72
of which mineral 21·00	
organic 55·72	
Free and saline ammonia - - - - - -	2·811
Organic ammonia - - - - -	1·624
Combined chlorine - - - - - - -	9·50
Oxygen absorbed 4 hours - - - - -	16·35

(15) Between what dates was the experiment conducted? If there were any periods of rest, state their duration. — These filters have only been used intermittently, but they have been worked for nine consecutive weeks at one time.

(16) Give particulars of any observations which have been made of the temperatures of the filters at different depths. — Not taken.

(17) Was any nuisance caused by the experimental works. — No.

(18) Is the experiment still proceeding? — No.

If so, may the Commission inspect the works, should they deem it desirable to do so? — Yes.

(19) Give particulars of any other observations of importance which have been recorded. — It has been found that wherever a certain dye class of sewage comes down to the works, it is not desirable to put this on the filters as it rapidly clogs the surface, also the clogging or stoppage takes place on the top of the filter, but does not go above 1 inch in depth.

(20) What inferences have been drawn from the experiment? — These beds will purify the Walsall sewage tank effluent after precipitation, so long as they are not worked at a greater rate than 400 gallons per square yard per 24 hours, and the surface well kept clean and free from clogging, and the sewage is put on to the beds in a "neutral state," except the dye sewage referred to previously, which would choke the beds in a short time.

(21) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state

(a) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.

(b) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

R. H. MIDDLETON,

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C, Form H.

EXPERIMENT ON THE TREATMENT OF SEWAGE BY CHEMICAL PRECIPITATION, SUBSIDENCE TANKS, AND CONTINUOUS FILTRATION.

Name of authority	Urban District Council of Withnell.
Population of district	3,750 (estimated).
Population of drainage area	2,600.
Water supply per head of the population, as registered by meter at water-works, for district supplied.	Nine gallons per day.
Estimated or measured dry weather flow of sewage	25,000 gallons per day.
Is any trade refuse taken into the sewers?	No.
If so, state from what processes it is derived, and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
	Note.—Storm water is turned into ordinary sewers, when storm sewers are fully charged, to prevent flooding.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Yes.
Officer under whom the experiment has been conducted	T. Beaver, Surveyor.
Name and qualification of chemist who has made the analyses.	No analyses made except by County Council inspector. These were not made to ascertain results of experiments; but for purposes under the Rivers Pollution Prevention Act.

(1) What was the nature of the chemical or chemicals used?	Alumino-ferric.
(2) What was the normal proportion of chemical or of chemicals (in grains per gallon) used?	15.
(3) State whether the chemicals were increased or decreased according to the nature and volume of the sewage treated, and give any particulars of such variations.	Nil.
(4) What is the capacity in gallons of the subsidence tanks?	33,264.
(5) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	20 tons (wet). Tanks cleaned daily.
(6) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Intermittent.
(7) (*a*) What are the form, the area and depth of the filters?	Form, oblong. Area, 60 yards sup. Depth, 3ft. of filtering materials.
(*b*) State the nature and size of the filtering material.	1 ft. of large gravel. 3 in. of small gravel. 9 in. of polarite and sand. 1 ft. of sand.
(*c*) Were the ides of the filters open or closed?	Closed.
(8) What was the rate of filtration in gallons per square yard per 24 hours?	500.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extend.	The filters have not choked in the least. They are washed every alternate day.
(9) What was the average quantity of sewage, in gallons, dealt with daily?	About 10,000.
(10) Was the quantity of sewage dealt with increased in time of storm?	No. Passed on to land.
If so, state to what extent, and how the results were affected by such increase.	
(11) State by what method the tank liquor was distributed on the filters.	By iron channel fixed in centre of filters. Tank liquor flowed into channel which overflowed.

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(12) State at what intervals analyses of the effluent were made, and whether the samples were filtered though filter paper or allowed to clear by standing, before being analysed.	None made by Council. County Council made analyses, generally satisfactory.
(13) Give (*a*) the average of the analyses of the final effluent from the filters ;	Albuminoid ammonia - - - - - ·060 Oxygen absorbed - - - - - ·23
(*b*) the best analysis and date when sample was taken ; and	May 3rd, 1900. Albuminoid ammonia - - - - ·041 Oxygen absorbed under - - - - ·20
(*c*) the worst analysis and date when sample was taken ;	July 30th 1896. Albuminoid ammonia - - - - ·058 Oxygen absorbed - - - - ·23
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters ;	Not known.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescrible ?	Not known.
(14) Give a typical analysis of the crude sewage to which the experiment relates.	Domestic sewage.
(15) Between what dates was the experiment conducted ?	From 1895 to date.
If there were any periods of rest, state their duration.	No.
(16) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	None taken.
(17) Was any nuisance caused by the experimental works ?	No. (Works close to village.)
(18) Is the experiment still proceeding ?	
If so, may the Commission inspect the works, should they deem it desirable to do so ?	Yes.
(19) Give particulars of any other observations of importance which have been recorded.	
(20) What inferences have been drawn from the experiment ?	That it is desirable for the tank effluent to be good before passing on to filters.
(21) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	Works extended so as to deal with three parts of the sewage, other part being treated on contact beds.
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	Cost of works, £1,000.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	Maintenance : £ Man's wage - - - - - 52 Precipitants - - - - - 12 Other charges - - - - - 6 70

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

THOMAS BEAVER.

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C.

Form K.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS FOLLOWED BY CONTINUOUS FILTRATION.

Name of authority - - - - - - - -	Malvern.
Population of district - - - - - - -	16,000.
Water supply per head of the population - - -	25 gallons per day.
Estimated or measured dry weather flow of sewage -	500,000 gallons per day.
Is any trade refuse taken into the sewers? - - - - If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	We have no trade refuse other than that from a brewery.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially.
Officer under whom the experiment has been conducted -	Engineer and Surveyor.
Name and qualification of chemist who has made the analyses.	C. C. Duncan, F.I.C., F.C.S., &c., analyst for the county of Worcester.
(1) What is the capacity in gallons of the subsidence tanks?	224,000 gallons.
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	14 tons. One tank emptied each week.
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Intermittent.
(4) (*a*) What are he form, the area and depth of the filters?	160 feet by 78 feet by 5 feet.
(*b*) State the nature and size of the filtering material.	In the experimental filter, constructed in May, 1898, fine coal only was used; latterly filters have been filled with clean clinkers and ashes, varying in size from $1\frac{1}{4}$-inch to $\frac{3}{8}$-inch cube.
(*c*) Were the sides of the filters open or closed? -	Closed.
(5) What was the rate of filtration in gallons per square yard per 24 hours?	About 200 gallons.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	We have had no choking.
(6) What was the average quantity of sewage in gallons dealt with daily.	From 280 to 300,000.
(7) Was the quantity of sewage dealt with increased in time of storm? If so, state to what extent, and how the results were affected by such increase.	Not on the filters.
(8) State by what method the tank liquor was distributed on the filters.	By means of rectangular galvanized carriers perforated in sides and bottoms.
(9) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Monthly. Allowed to clear by standing before analysis.
(10) Give (*a*) the average of the analyses of the final effluent from the filters.	Parts per 100,000: Total solids, 58·98. Chlorine as common salt, 8·856. Free ammonia, 1·19 Albuminoid ammonia, ·38. Oxygen absorbed in three hours, 2·983.
(*b*) The best analysis and date when sample was taken, and	6th March 1899.
(*c*) The worst analysis and date when sample was taken.	24th January 1899.

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(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters ;	No record taken.
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible ?	No record taken beyond analyst's returns. The solids were not putrescible.
(11) Give a typical analysis of the crude sewage to which the experiment relates.	Parts per 100,000 : Total solids, 61·28. Chlorine as common salt, 16·352. Free ammonia, 4·00. Albuminoid, ·20. Oxygen absorbed in two hours, 33·08.
(12) Between what dates was the experiment conducted ?	May, 1898, and April, 1899, ten hours each day : viz., from 8 p.m. to 6 a.m.
If there were any periods of rest, state their duration.	
(13) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	None taken.
(14) Was any nuisance caused by the experimental works ?	No.
(15) Is the experiment still proceeding ?	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so ?	Certainly.
(16) Give particulars of any other observations of importance which have been recorded.	
(17) What inferences have been drawn from the experiment ?	That the disposal of sewage by means of subsidence tanks and filters is the surest and most economical way of producing a good effluent.
(18) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	About 4*s.* 2*d.*
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	About 2¼*d.*

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

H. P. Maybury,
Engineer and Surveyor.

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form K.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN SUBSIDENCE TANKS FOLLOWED BY CONTINUOUS FILTRATION.

Name of authority	Urban District Council of Rothwell (Northampton).
Population of district	4,500.
Water supply per head of the population	Supplied by wells.
Estimated or measured dry weather flow of sewage	60,835 gallons per day.
Is any trade refuse taken into the sewers?	No.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Excluded from streets.
Officer under whom the experiment has been conducted.	Surveyor.
Name and qualification of chemist who has made the analyses.	None.
(1) What is the capacity in gallons of the subsidence tanks?	12,000 gallons.
(2) State what quantity of sludge was produced weekly in the subsidence tanks, and at what intervals the sludge was removed.	1 ft. Fortnightly.
(3) State whether the flow of sewage through the subsidence tanks was continuous or intermittent.	Continuous.
(4) (*a*) What are the form, the area and depth of the filters?	60 ft. × 18 ft. × 5 ft. deep.
(*b*) State the nature and size of the filtering material	½ in. honeycomb slag chippings.
(*c*) Were the sides of the filters open or closed?	Open.
(5) What was the rate of filtration in gallons per square yard per 24 hours?	250 gallons.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	No.
(6) What was the average quantity of sewage in gallons dealt with daily?	40,000 gallons.
(7) Was the quantity of sewage dealt with increased in time of storm?	Yes.
If so, state to what extent, and how the results were affected by such increase.	50 per cent. not so good.
(8) State by what method the tank liquor was distributed on the filters.	Through 4 in. iron pipes under a head of 3 ft. and distributed in the shape of rain.
(9) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.	None.
(10) Give (*a*) the average of the analyses of the final effluent from the filters.	
(*b*) the best analysis and date when sample was taken, and	
(*c*) the worst analysis and date when sample was taken.	
(*d*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the filters.	
(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?	

(11) Give a typical analysis of the crude sewage to which the experiment relates.	
(12) Between what dates was the experiment conducted?	One year.
If there were any periods of rest, state their duration.	Month at intervals.
(13) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	
Was any nuisance caused by the experimental works?	Yes.
(15) Is the experiment still proceeding?	Yes, on different lines.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(16) Give particulars of any other observations of importance which have been recorded.	Continuous filtering was found to be unsatisfactory. The tanks have now been enlarged and covered, in and it is intended to work the filter intermittently.
(17) What inferences have been drawn from the experiment?	That by running the effluent over grass land after filtering good results are obtained. We are now completing a scheme whereby the sewage will pass through the covered tank first, secondly through the filter, and then pumped 60 feet high on to a grass field 18 acres in extent collected by a drain at the lower part of the field and finally conveyed on to ploughed land by gravitation.
(18) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	7*s.* 9*d.*
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	6*d.* The total cost of the works is £1,700. The annual cost will be under £100 per year for working the pumping plant and the last is worked at a profit.

Note 1.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus :—

Ammoniacal nitrogen ;
Albuminoid nitrogen ;
Nitrous nitrogen ;
Nitric nitrogen ;
Total organic nitrogen.

Note 2.—The expression "subsidence tanks" is intended to denote tanks which are used so that little or no "septic" action is produced.

W. Z. PEARSORT,
Surveyor to the Council.

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C.

Form M.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE BY CONTINUOUS FILTRATION.

Name of authority	Newmarket Urban District Council.
Population of district	10,000 (estimated), 8,000 contributing to sewage farm.
Water supply per head of the population	About 20 gallons per day, per head. — Cannot give quantity, as company also supply outside urban district.
Estimated or measured dry weather flow of sewage	Average 160,000 gallons per day.
Is any trade refuse taken into the sewers?	No trade wastes in Newmarket.
If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of trade refuse.	No.
Is the storm, soil, or surface water, wholly or partially, excluded from the ordinary sewers?	Storm water partially excluded.
Officer under whom the experiment has been conducted.	The surveyor to the Urban District Council.
Name and qualification of chemist who has made the analyses.	J. West Knights, F.I.C., &c., County Analyst, Cambs.
(1) (a) What are she form, the area and depth of the filters?	Two filters, each 125 feet by 25 feet by 3 feet deep. Area of each filter, 347 square yards.
(b) State the nature and size of the filtering material.	Ashes from the dry dust bins, after being burnt and screened (practically what would be rejected on a ½-inch screen).
(c) Were the sides of the filters open or closed?	Closed.
(2) What was the rate of filtration in gallons per square yard per 24 hours?	100 gallons per square yard.
State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.	No; the outlet valve to filters was kept open and the filters used as open filters, the sewage not being locked in.
(3) What was the average quantity of sewage in gallons dealt with daily?	40,000 gallons.
(4) Was the quantity of sewage dealt with increased in time of storm?	No.
If so, state to what extent, and how the results were affected by such increase.	
(5) State by what method the sewage was distributed on the filters.	By means of wooden carriers on surface of beds.
(6) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing before being analysed.	Approximately, monthly.
(7) Give (a) the average of the analyses of the final effluent from the filters.	parts per 100,000. (a) Albuminoid ammonia - - - - 1·57 Oxygen absorbed at 140° F. (15 minutes) - - - 1·215
(b) the best analysis and date when sample was taken, and	(b) Albuminoid ammonia, ·05, 17th July, 1900. Oxygen absorbed, ·84, „ „ „
(c) the worst analysis and date when sample was taken.	(c) Albuminoid ammonia ·3, 25th January, 1900. Oxygen absorbed, 1·87 „ „ „
(d) the average of the estimations made of the solids in suspension in the sewage as it went on to the filters.	87·87.
(e) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?	·16 (trace)

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Question	Answer
(8) Give a typical analysis of the crude sewage to which the experiment relates.	Crude sewage: Solids (mineral) - - - - - - - 87·00 „ (organic) - - - - - - - 90·00 Chlorine - - - - - - - - - 16·00 Equal to chloride of sodium (salt) - - - 26·60 Nitrates (expressed as nitrogen) - - - none Ammonia (free) - - - - - - - 15·50 „ (albuminoid) - - - - - - ·70 Oxygen absorbed at 140° F. (15 minutes) - 10·00 Suspended matter - - - - - - 80·00
(9) Between what dates was the experiment conducted? If their were any periods of rest, state their duration.	August, 1899, to September, 1900. One day per week at least.
(10) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	No observations taken of temperatures.
(11) Was any nuisance caused by the experimental works?	No.
(12) Is the experiment still proceeding? If so, may the Commission inspect the works, should they deem it desirable to do so?	No.
(13) Give particulars of any other observations of importance which have been recorded.	My experience of the treatment of domestic sewage on filters containing cinders and ashes dictates that :— (*a*) 80 gallons per square yard per day should be the maximum rate of filtration. (*b*) The minimum depth of material should be three feet, and no particular advantageis gained by making the beds more than four feet deep. (*c*) A period of rest of at least one day in a week should be given. (*d*) Clean screened cinders or clinker (not larger than walnut size) for coarse beds, and (*e*) Coke breeze, clinker, ashes, or coarse sand, for fine beds, passed through a ¼-inch screen will all give good results.
(14) What inferences have been drawn from the experiment?	(*f*) Two operations are necessary, viz., coarse beds and fine beds, to get a satisfactory effluent. (*g*) A prior screening, together with a sedimentation tank before the sewage is run on to the filters, is necessary to avoid choking of beds and consequent diminution of liquid capacity. (*h*) 60 per cent. of purification can be maintained in each operation, or 90 per cent. combined, both on the albuminoid and oxygen absorbed test.
(15) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	About 10*s.* per head.
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	About 6*d.*

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:

Ammoniacal nitrogen
Albuminoid nitrogen
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

JOHN W. METCALF, Surveyor

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C. Form M.

EXPERIMENT ON THE TREATMENT OF CRUDE SEWAGE BY CONTINUOUS FILTRATION.

Name of authority	Stone (Staffs) Urban District Council.
Population of district	5,678.
Water supply per head of the population	19 gallons per day.
Estimated or measured dry weather flow of sewage	257,000 (estimated) gallons per day.
Is any trade refuse taken into the sewers? If so, state from what processes it is derived and, approximately, what percentage of the total dry weather flow of sewage is made up of dry refuse.	Brewery waste from $\frac{1}{3}$ to $\frac{1}{2}$ dry weather flow.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Surface water partially excluded.
Officer under whom the experiment has been conducted.	Under myself, according to directions of Dr. Reid, County Medical Officer, Stafford.
Name and qualification of chemist who has made the analyses.	George Reid, M.D., D.P.H.

(1) (*a*) What are the form, the area and depth of the filters?

Double filtration. Each filter 12 ft. × 9 ft. × 3 ft. 9 in. deep.

(*b*) State the nature and size of the filtering material.

First filter. Engine ashes of sizes from below upwards as follows: 6 in. of 1-in. particles, 6 in. of $\frac{1}{2}$-in. particles 2 ft. 9 in. of $\frac{1}{4}$-in. particles.
Second filter. Coal of sizes from below upwards as follows: 6 in. of $\frac{1}{2}$-in. particles, 6 in. of $\frac{1}{4}$-in particles, 2 ft. 9 in. of $\frac{3}{16}$-in. and $\frac{1}{16}$ in. mixed.

(*c*) Were the sides of the filters open or closed?

Closed.

(2) What was the rate of filtration in gallons per square yard per 24 hours?

Filters worked at the rate of 200 gallons per square yard for a period of 12 hours and then rested 12 hours.

State whether the rate of filtration was reduced during the experiment in consequence of the choking of the filters, and, if so, to what extent.

No.

(3) What was the average quantity of sewage in gallons dealt with daily?

2,400.

(4) Was the quantity of sewage dealt with increased in time of storm?

No.

If so, state to what extent, and how the results were affected by such increase.

(5) State by what method the sewage was distributed on the filters.

Series of transverse tippers supplied from longitudinal troughs, the interval between each tipper being 12 inches.

(6) State at what intervals analyses of the effluent were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.

About three weeks intervals. Neither filtered nor allowed to stand.

(7) Give (*a*) the average of the analyses of the fina effluent from the filters.

Solids, In solution	66·8
Solids, ,, suspension	1·4
Total	68·2
Chlorine	7·0
Ammoniacal nitrogen	0·25
Albuminoid nitrogen	0·11
Nitric nitrogen	0·98
O absorbed in 4 hours at 80° F.	0·68

(*b*) the best analysis and date when sample was taken, and

(*c*) the worst analysis and date when sample was taken.

	(*b*) January 5th 1900.	(*c*) March 28th 1899.
Solids, In solution	67·0	6·2
Solids, ,, suspension	Nil	Nil
Total	67·0	62
Chlorine	6·0	7·2
Ammoniacal nitrogen	0·013	0·215
Albuminoid nitrogen	0·035	0·176
O absorbed in 4 hours at 80° F.	0·308	1·108

(*d*) the average of the estimations made of the solids in suspension in the sewage as it went on to the filters.

39·3 parts per 100,000.

(*e*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?

(1) 1·4; (2) not ascertained.

(8) Give a typical analysis of the crude sewage to which the experiment relates.	Mean of 14 samples. Solids { In solution - 71·0 „ suspension - 39·3 Total - 110·3 Chlorine - 6·7 Ammoniacal nitrogen - 2·16 Albuminoid - 1·48 O absorbed in four hours at 80° F. - 5·11
(9) Between what dates was the experiment conducted?	February 22nd, 1899, to February 7th, 1900.
If there were any periods of rest, state their duration.	Sundays only.
(10) Give particulars of any observations which have been made of the temperatures of the filters at different depths.	No observations made.
(11) Was any nuisance caused by the experimental works?	Nuisance has been complained of.
(12) Is the experiment still proceeding?	No.
If so, may the Commission inspect the works, should they deem it desirable to do so?	
(13) Give particulars of any other observations of importance which have been recorded.	During the experiment a volume of wet sludge, equal to four times the available capacity of one of the tanks, has absolutely disappeared, leaving the filters as clean and free from deposit as when first constructed.
(14) What inferences have been drawn from the experiment?	The plant can dispose of the sewage in question, but it is believed that better results would be obtained by liquefying the sewage in the first instance and a Scott-Moncrieff tank has been put down to pass sewage through before it is discharged on to filters. This is now stopped.
(15) If it is considered that it would be practicable to adopt this system for the disposal of the whole of the sewage of the district, please state	
(*a*) what would be the estimated capital cost per head of constructing the works of disposal, excluding the cost of land and cost of sewers.	
(*b*) what would be the estimated annual cost per head of purifying the sewage by this system, excluding the annual repayment of any loan.	

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

A. R. Ridout, Surveyor.

Signature of Officer under whose direction the experiment was conducted.

Appendix 9C.

BIRMINGHAM, TAME, AND REA DISTRICT DRAINAGE BOARD.

Tyburn, near Birmingham.
January 21st, 1901.

William Harris, Esq., J.P., 9, Bennett's Hill, Birmingham.

Dear Sir,—With reference to the request of the Secretary of the Royal Commission on Sewage Disposal for information regarding any experiments which have been conducted at our works, I beg to say that we have been experimenting on a large scale with open septic tanks, and the results have been to a large extent of a satisfactory kind. First of all a marked reduction in the amount of sludge requiring to be dealt with has been apparent. During the past six months 76,170 cubic yards of sludge have been removed, as compared with 149,170 cubic yards of sludge during the corresponding period of last year. I am satisfied that this result is largely due to the fact that the sewage from our roughing tanks (three in number and having a capacity of 3,000,000 gallons) is passed into 16 open septic tanks, having a total capacity of 4,500,000 gallons, where it is liquefied and peptonised in an extraordinary manner. For a similar period, viz., the six months ending 21st November, the road detritus, which was taken from the first bay of the roughing tanks, showed an increase of quantity equal to 377 cubic yards as compared with last year. During three months prior to 21st November lime had been used as a precipitant; since then no chemical precipitant has been used, and I think there can be no doubt that the cessation of the liming operation contributed towards a more active condition of the septic tanks than during the three months immediately preceding, when milk of lime was added to the sewage prior to its entering the roughing or precipitation tanks. Another benefit which has accrued from the use of the 16 open tanks as septic tanks is to be found in the improvement in the deposit which takes place in the land tile drains; this deposit consists chiefly of a basic compound of iron and iron oxide, and its amount and nature seems to have changed since the septic tank process has been in use; whereas formerly it formed itself into large flakes of a gelatinous nature, it is now much finer and less coherent, and our chemist attributes this to the smaller amount of organic matter present owing to the preliminary action of the septic tank. On analysis he found it to contain:—

Volatile and organic matters.	Nitrogen.	Silica (Sand)	Iron Oxide.	Lime.
34·33	2·30	31·76	24·48	3·58

And Alkalies, etc., 5·85 per cent.

The benefit thus derived from the use of the septic tank, and from the cultivation of the anaerobic organism before the sewage is applied to the land, is a very real one, not so much from the point of view of pollution of the river as from the lessening of the chances of chokage in the land drains.

Another advantage which was found to accrue from the use of septic sewage was the greater fertilizing properties of the sewage, *i.e.* the growth of kohl rabi on field No. 32 was very marked, and the farmer under whose supervision that field was planted tells me that it was better than what was formerly got from the same field when it was well manured with farmyard manure. Again, the rye grass has been particularly good this year, one field yielding no fewer than six crops, and our chemist, whose attention I directed to this, says:—"The septic tank effluent contains large quantities of matter essential to plant growth. This matter is present in a form in which it is more easily available to the plant than it is in the case of the precipitation tank effluent. Also, the septic tank effluent contains much more suspended matter than the other, and this solid matter is spread over the whole area of the farm, and tends to enrich the ground for agricultural purposes."

As it has been suggested by at least one authority that the use of septic sewage on grass or pasture land invariably results in discoloration, and frequently destruction of the crop, I wish to observe that this has not been our experience. I can point to grass land which has been receiving sewage [septic tank liquor G. M.] three days a week, and it is about as green and fresh to-day as it was in the early spring of 1900, when the septic sewage was first applied to it. Generally the quality of the grass all over the farm has been good this year, and when mowed never showed the slightest discoloration at the roots.

I was reluctant to try the effect of septic sewage on land, as I feared that the increased amount of matter in suspension in it, as compared with the sewage formerly sent from Saltley, would tend to clog up the pores of the soil, and probably interfere with the carrying capacity of the great sewer itself. This fear has not been justified in practice. The sewer is as free of deposit now as it was nine months ago, and the filtration bed and land generally is in my view freer of deposit than it was when treated to limed sewage. Even where black scum has been found it dries and cracks readily, and is not of the same indiarubber like quality as the old scum.

I cannot point to any real disadvantage in using septic sewage on land, but there is one point which I think has not been properly settled, and that is whether the limed sewage which formerly flowed on to the land assisted in producing nitrification of the effluent. Our farm is working under abnormal conditions at present, and I do not think we are in a position to form a safe opinion on this subject until the quantity of sewage supplied to the land is reduced from 34,000 gallons per acre to 20,000 gallons per acre in the case of downward intermittent filtration, and this we shall not be able to do for two years to come.

As you are aware, the Works Committee have had a report on this subject under consideration for the past two months, and they have resolved to meet specially to consider whether my recommendation to continue the use of septic sewage, and to abandon the use of lime as a precipitant, should be adopted as a permanent policy. This meeting I expect will be held within the next three weeks.

I am, yours faithfully,

(Signed) JOHN D. WATSON,

Engineer to the Board.

Appendix 9C.

Form.

EXPERIMENT ON THE TREATMENT OF SEWAGE IN OPEN SEPTIC TANK FOLLOWED BY LAND TREATMENT.

Name of authority - - - - - - - -	Birmingham, Tame, and Rea District Drainage Board.
Population of district - - - - - - - -	750,000.
Water supply per head of the population - - -	Probably between 25 and 30 gallons per day.
Estimated or measured dry weather flow of sewage -	25,000,000 gallons per day.
Is any trade refuse taken into the sewers? - - - -	Yes.
If so, state from what processes it is derived, and, approximately, what percentage of the dry weather flow of sewage is made up of trade refuse.	A great variety of trades, the chief of which are connected with brass and iron works. Percentage about one-fifth.
Is the storm, soil or surface water, wholly or partially, excluded from the ordinary sewers?	Partially excluded.
Officer under whom the experiment has been conducted -	The Engineer to the Board.
Name and qualification of chemist who has made the analyses.	F. R. O'Shaughnessy, Assoc. Royal College of Science, Member Society of Public Analysts, &c.
(1) (*a*) What is the capacity in gallons of the open septic tank or tanks?	$4\frac{1}{2}$ million gallons, plus three settling tanks capable of holding $2\frac{3}{4}$ million gallons.
(*b*) If there was more than one tank, state whether they were worked in series or in parallel.	In parallel.
(2) Were any observations made as to the filling up of the septic tanks by deposit of sludge?	When equilibrium was established a small black residue of apparently constant quantity and uniform consistency remained at bottom.
If the sludge was removed from the septic tanks, state how often this was done and, approximately, what quantity of sludge was removed on each occasion.	It has not been necessary to remove any sludge from the septic tanks proper ($4\frac{1}{2}$ million gallons capacity). 76,000 cubic yards of sludge have been removed during the past six months from the large precipitation tanks (capacity $2\frac{3}{4}$ million gallons).
(3) What was the average quantity of sewage in gallons dealt with daily in the septic tanks?	15,000,000.
(4) Was the quantity of sewage dealt with increased in time of storm?	Yes.
If so, state to what extent, and how the results were affected by such increase.	No serious interference was felt till November last, when storm water caused nitrates, etc., to appear, and since then the tanks have not recovered.
(5) State at what intervals analyses were made, and whether the samples were filtered through filter paper or allowed to clear by standing, before being analysed.	Analyses of tank effluent were made as a rule several times per month. When time permitted they were made several times per week. Land effluents were examined oftener. "Free" and "albuminoid ammonias" were determined on unfiltered sample.
(6) Give (*a*) the average of the analyses of the final effluent from the land;	See page 435.
(*b*) the average of the estimations of the solids in suspension in the sewage as it went into the tanks;	See page 435.
(*c*) the average of the estimations made of the solids in suspension in the tank liquor as it went on to the land;	21·1.
(*d*) the average of the estimations made of the solids in suspension in the final effluent. Were these solids putrescible?	It rarely amounts to more than a trace, and is usually sandy when present. A basic precipitate of iron with organic matter forms in the land drains and causes turbidity when these are flushed.
(7) Give a typical analysis of the crude sewage to which the experiment relates.	See page 435.

Appendix 9C.

(8) Between what dates was the experiment conducted?	Between March and November, 1900. The septic tanks required about 2 months, *i.e.* till June, to get into full working order.
If there were any periods of rest, state their duration.	The experiment was continuous.
(9) Was any nuisance caused by the experimental works?	No.
(10) Is the experiment still proceeding? - - - -	Yes.
If so, may the Commission inspect the works, should they deem it desirable to do so?	Yes.
(11) Give particulars of any other observations of importance which have been recorded.	Sludge has been greatly reduced. Suspended matter increased in tank effluent. Exceptionally good crops yielded by land treated with this "septic" sewage.
(12) What inferences have been drawn from the experiment?	Chief inference is that a preliminary septic treatment gives greater efficiency to works and a land effluent better than that from a preliminary chemical treatment.

Note.—It is requested that all analyses may be stated in parts per 100,000, and that the various compounds of nitrogen may be given in terms of nitrogen, thus:—

Ammoniacal nitrogen;
Albuminoid nitrogen;
Nitrous nitrogen;
Nitric nitrogen;
Total organic nitrogen.

JOHN D. WATSON, Assoc.M.Inst.C.E.
Signature of Officer under whose direction the experiment was conducted.

ANSWERS TO QUESTIONS IN THE ABOVE FORM.

(6) *a.* Analyses of final effluent from the land.

Dissolved Solids.	Suspended Matter.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Chlorine.	Nitrates, &c. as Nitrogen.	Oxygen absorbed.	Name of Outfall Carrier.
112·3	Trace	·96	·07	13·8	·31	1·09	Castle Bromwich.
113·8	3·5	·56	·09	6·5	·15	1·05	Plants Brook.
81·0	Trace	1·52	·11	11·1	·23	1·33	Lowe's Carrier.
89·5	0·5	1·66	·10	12·4	·26	1·62	Water Orton.

The above are some average analyses of principal outfall effluents. The analyses of different individual fields vary widely, the quality depending on the field. Compared with the latter the above show some dilution from small streams and probably also subsoil water.

(6) *b.* Analyses of sewage from principal sewers.

Dissolved Solids.	Suspended Matter.	Ammoniacal Nitrogen.	Albuminoid Nitrogen.	Chlorine.	Nitrates, &c. as Nitrogen.	Oxygen absorbed. Filtered.	Oxygen absorbed. Unfiltered.	Total Organic Nitrogen.	Name of Sewer.
156·0	51·8	2·27	·99	12·6	·35	7·30	14·62	4·06	Saltley.
138·2	47·5	3·09	1·45	23·9	·62	11·85	16·92	3·65	Rea.
139·3	59·6	2·73	1·22	21·8	·91	5·38	12·79	6·87	Hockley.
94·6	47·6	3·14	1·38	10·8	·26	—	9·85	6·88	Aston.

The bulk of the sewage treated is brought to the works by the above four sewers. The contents of these sewers are mixed in the preliminary settling or "roughing" tanks.

(6) *d.* Analysis of growth in land drains.

Volatile and Organic Matter.	Total Nitrogen.	Silica (Sand).	Iron Oxide and Alumina.	Lime (CaO.)	Undetermined matter.
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
34·33	2·30	31·76	24·48	3·58	5·85

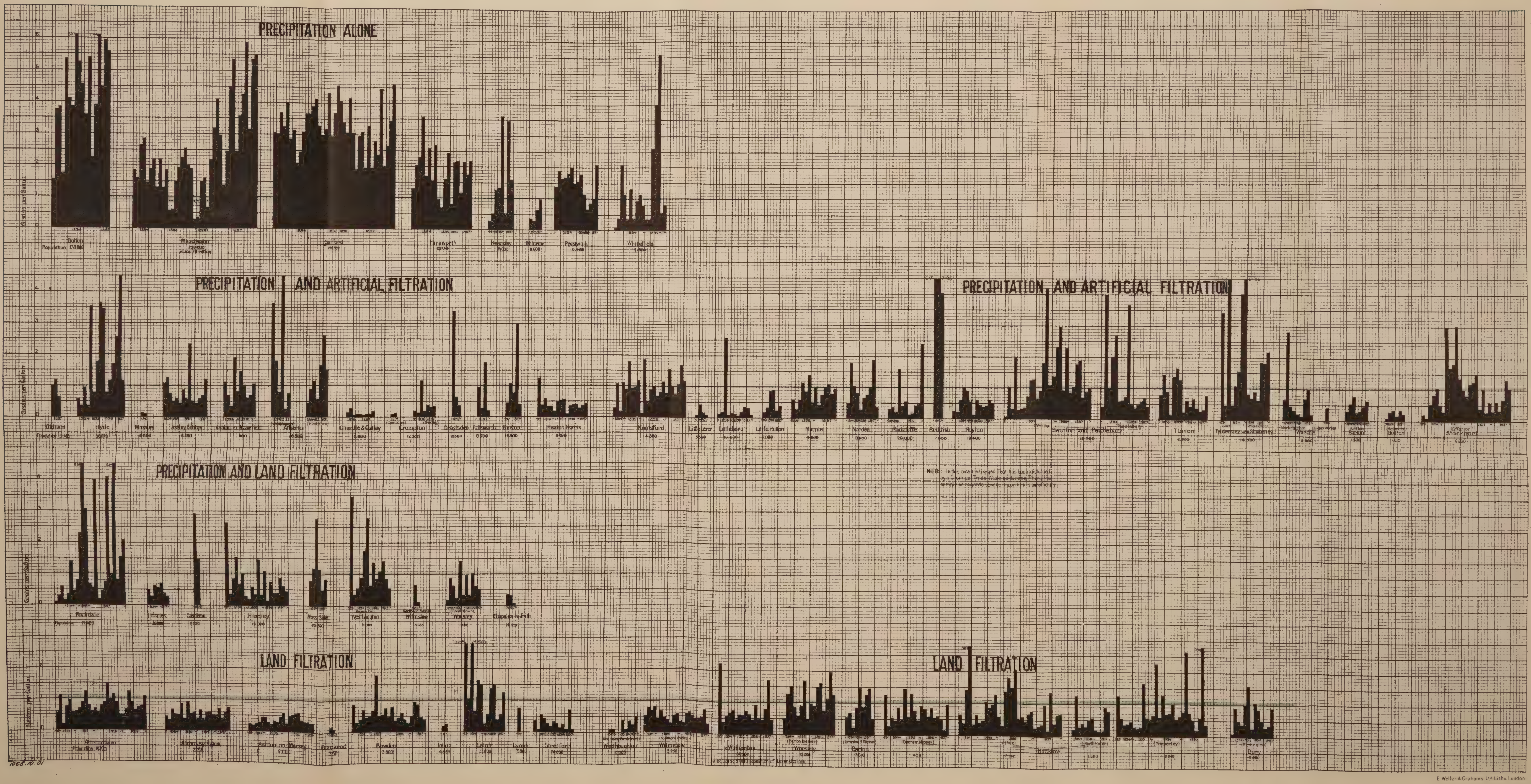
APPENDIX, No. 10.

APPENDIX No. 10.

HANDED IN BY R. A. TATTON, M. I. C. E., CHIEF INSPECTOR OF THE MERSEY AND IRWELL JOINT COMMITTEE.

MERSEY AND IRWELL JOINT COMMITTEE.

DIAGRAM SHEWING RESULTS OF ANALYSIS OF SAMPLES OF EFFLUENT TAKEN FROM THE VARIOUS SEWAGE WORKS DURING THE YEARS 1893 TO 1897.
THE RESULTS ARE EXPRESSED IN GRAINS PER GALLON OF OXYGEN ABSORBED - 4 HOURS TEST.



APPENDIX, No. 11.

APPENDIX No. II.

HANDED IN BY F. SCUDDER, F.C.S., F.I.C., ACTING CHEMIST TO THE MERSEY AND IRWELL JOINT COMMITTEE.

MANCHESTER SEWAGE WORKS.

Diagram shewing the "putrefactive power" of the (1) Tank Effluent (2) Wilson Filtrate (Mechanical filtration) and the "Oxidation power" of the (3) Cinder Filtrate and (4) Coke Filtrate.

Oxygen Absorbed 3 minutes test 1 inch Vertical = 0·25 grain Oxygen per gallon.

Red Column = Original sample as analysed.

Red + Black columns = Sample analysed after 7 days in stoppered bottles kept at a temperature of 75·5° Fahr.

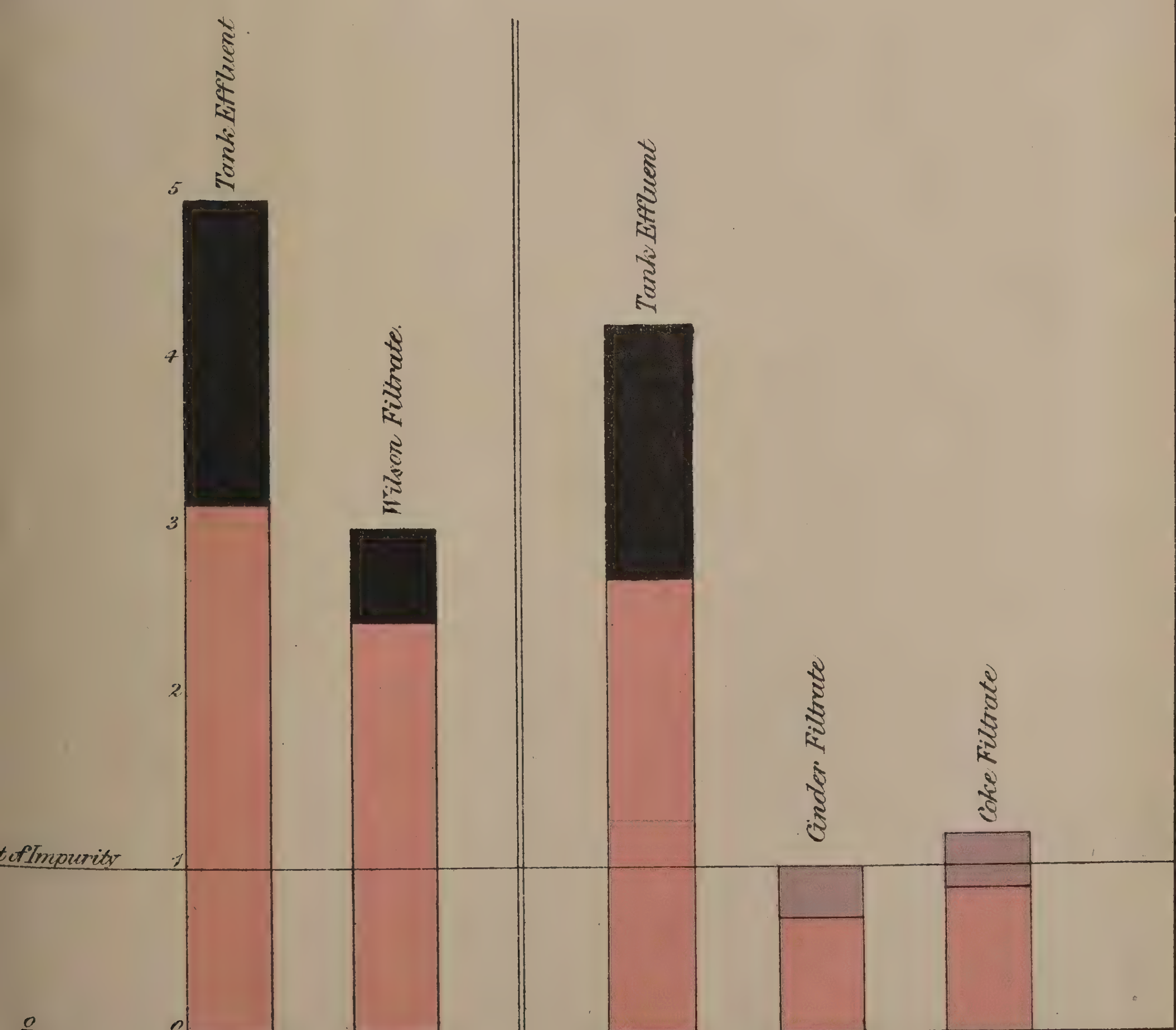
Black column = "putrefactive power" of sample.

Cinder & Coke filtrates do not possess any "putrefactive power" but a tendency to "oxidize."

Red + purple columns = Original sample as analysed.

Red column = sample analysed after 7 days.

Purple column = "Oxidation power of sample."



FRANK SCUDDER F.I.C.

APPENDIX, No. 12.

Appendix No. 12.

Handed in by Dr. H. Maclean Wilson, M.D., B.Sc.
Chief Inspector of the West Riding of Yorkshire Rivers Board.

"West Riding Rivers Conservancy Bill 1894."

Valley	Area	Population	Main River Miles	Tributaries Miles	Direct Trade Pollutions.
AIRE	280.000	880.000	90	110	349
CALDER	240.000	670.000	50	80	672
DON	330.000	670.000	70	100	143
OUSE (INCLUDING OUSE, WHARFE, NIDD & URE.)	550.000	150.000	210	150	75
TRENT	100.000	27.000	0	40	6
LUNE & RIBBLE	250.000	25.000	37	120	10
MERSEY	18.500	18.000	0	20	41

E. Weller & Grahams, Ltd Litho. London.

APPENDIX, No. 13.

APPENDIX No. 13. HANDED IN BY Dr. H. MACLEAN WILSON, M.D., B.Sc.
CHIEF INSPECTOR OF THE WEST RIDING OF YORKSHIRE RIVERS BOARD.

PLAN SHEWING THE BASIN OF THE RIVER CALDER.

5.10.1901.

E. Weller & Grahams, Ltd Litho. London

APPENDIX, No. 14.

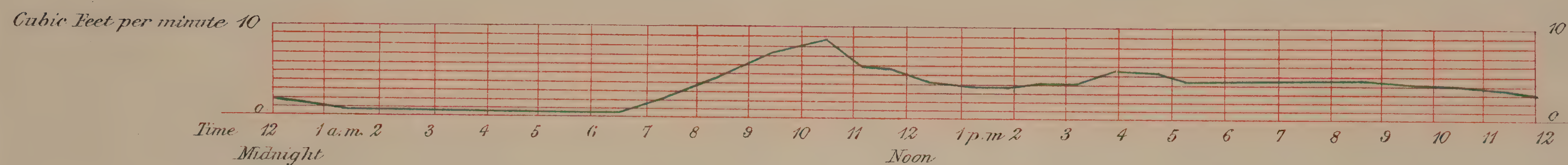
A.

Appendix No. 14

Handed in by Donald Cameron Esq:

Exeter Sewage Scheme.

Dry Weather Gaugings.



City Engineer & Surveyor's Office
Exeter.

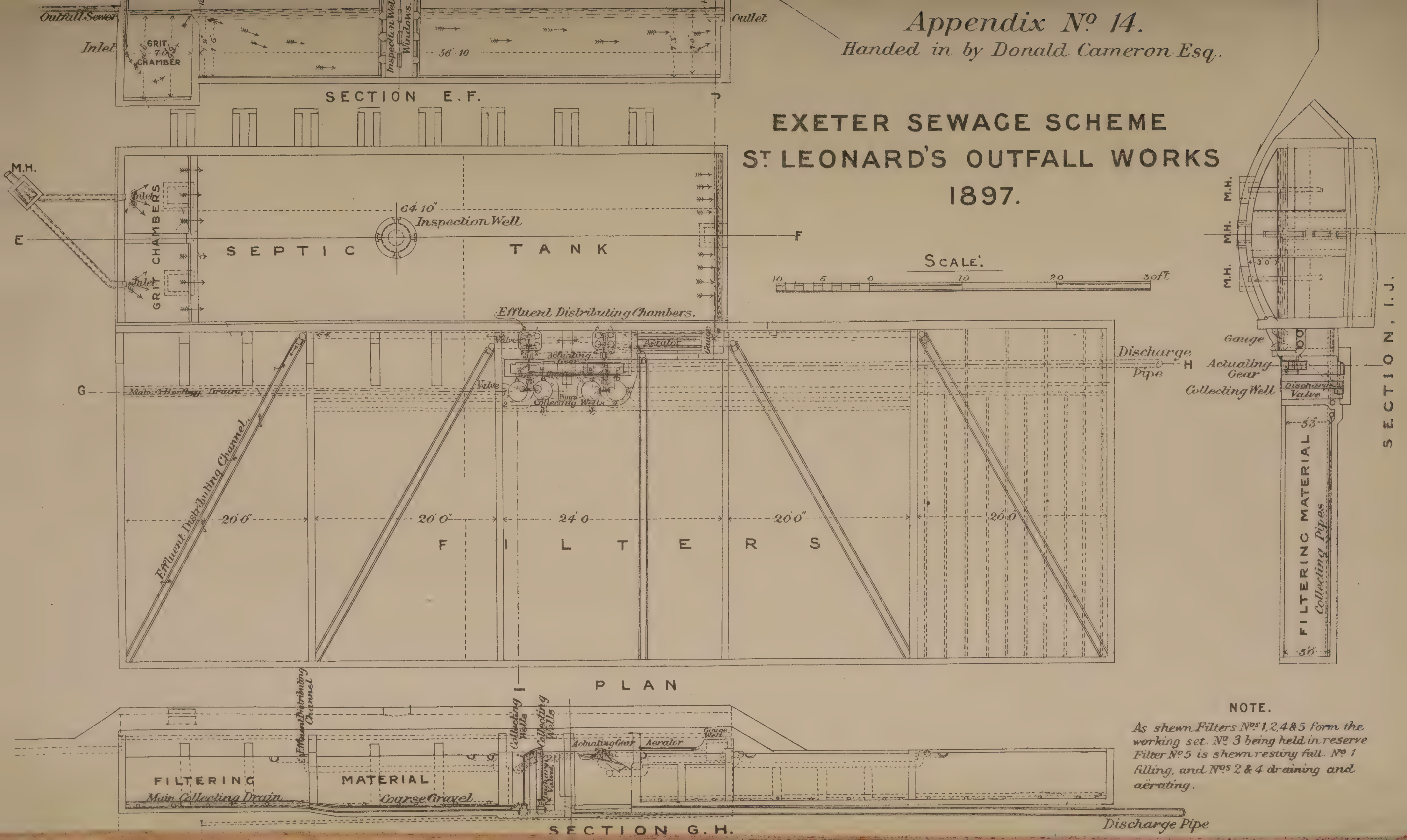
1065 · 1 · 02

E. Weller & Grahams, Ltd Litho. London.

Appendix No. 14.

Handed in by Donald Cameron Esq.

EXETER SEWAGE SCHEME
ST. LEONARD'S OUTFALL WORKS
1897.



NOTE.

As shewn Filters Nos 1, 2, 4 & 5 form the working set. No 3 being held in reserve. Filter No 5 is shewn resting full. No 1 filling, and Nos 2 & 4 draining and aërating.

APPENDIX, No. 15.

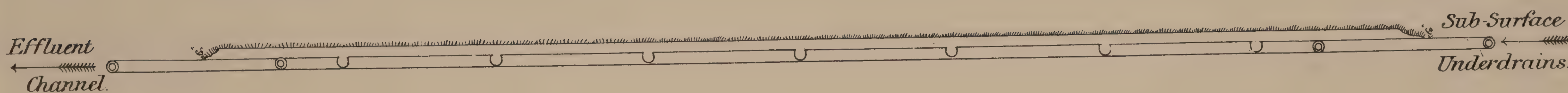
Appendix No. 15.

A

Handed in by Mr W. J. Dibdin.

DISPOSAL OF SEWAGE, EFFECTS OF LAND TREATMENT

SURFACE ACTION ON CLAY.



2, Edinburgh Mansions,
Howick Place, Victoria St
Westminster, October, 1898.

Wyman & Sons, Ltd, Lith, 63. Carter Lane 3382. 11. 98.

B

Handed in by Mr W. J. Dibdin.

DISPOSAL OF SEWAGE. ÷ EFFECTS OF LAND TREATMENT.

SURFACE AND IMMEDIATE SUBSURFACE ACTION ON CULTIVATED CLAY.

2 Edinburgh Mansions,
Howick Place, Victoria St.
Westminster.

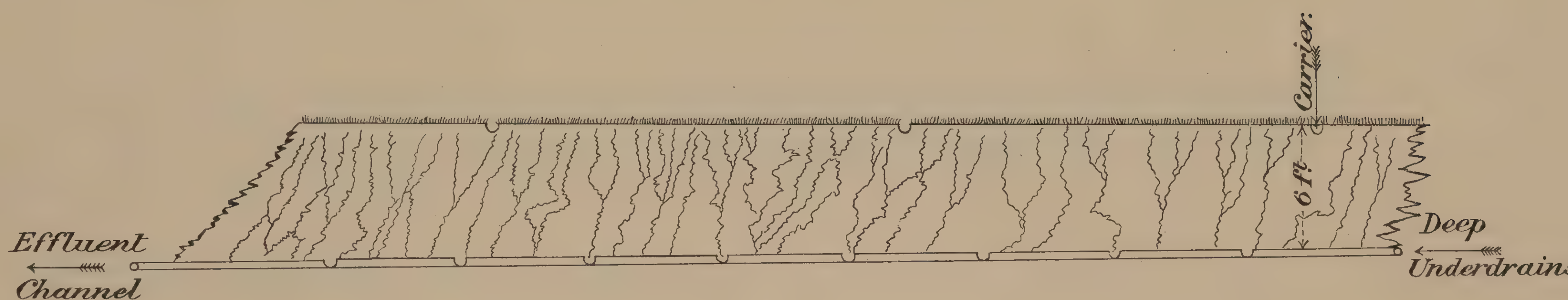
Wyman & Sons, Ltd, Lith, 63, Carter Lane. 3382 10.98

Appendix No. 15.
Handed in by W. J. Dibdin, Esq.,

C

DISPOSAL OF SEWAGE, EFFECTS OF LAND TREATMENT,

PARTIAL ACTION OF POROUS SOIL (GRAVEL, ETC.)
SEWAGE RUNNING IN CHANNELS DIRECT TO UNDERDRAINS.



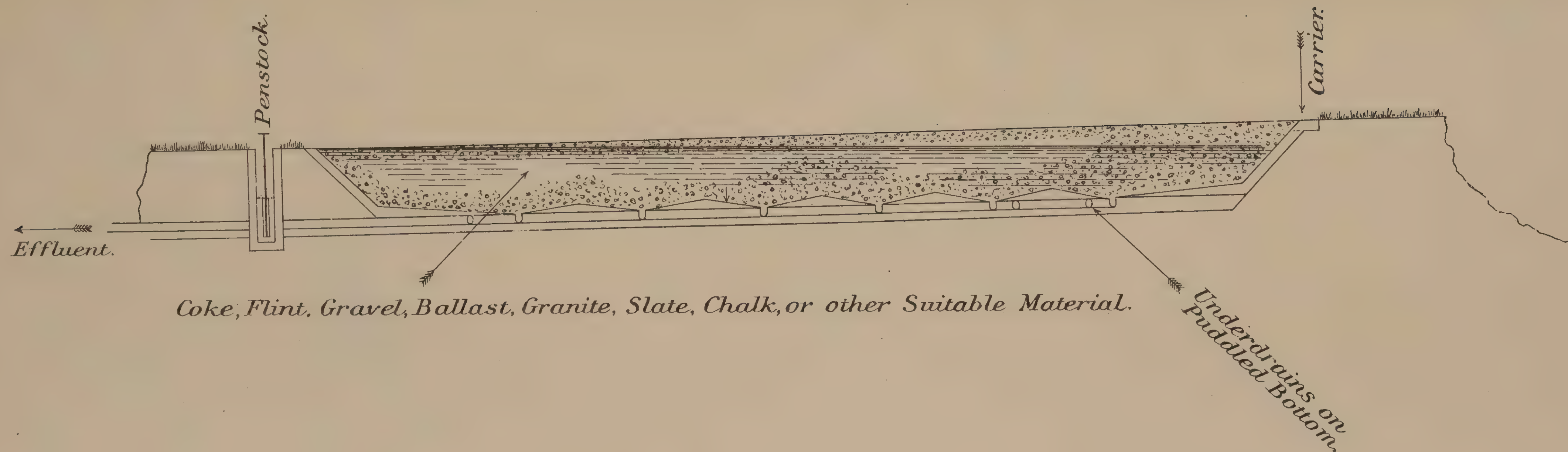
2, Edinburgh Mansions,
Howick Place, Victoria St.
Westminster.

October 1898.

Handed in by W. J. Dibden Esq.

D

IMPROVED LAND OR BACTERIA TREATMENT.



2 Edinburgh Mansions,
Howick Place, Victoria Street,
Westminster.

3382. 8. 01.

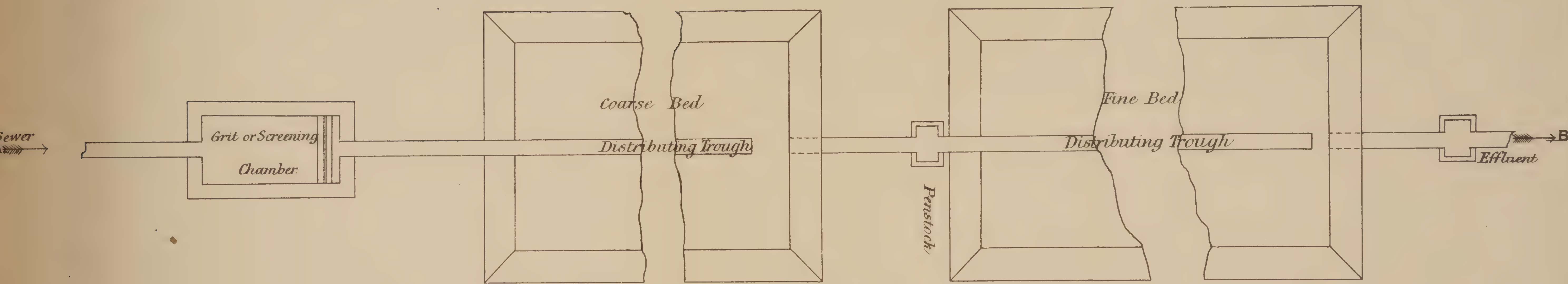
Appendix No. 15.

E

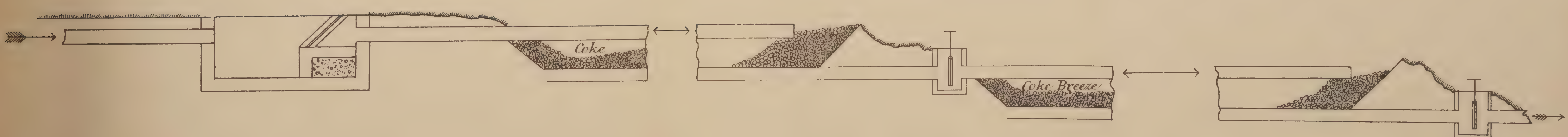
Handed in by Mr W. J. Dibdin.

SKETCH SHOWING PAIR OF TYPICAL BACTERIA BEDS.

PLAN



SECTION ON LINE A—B.



Wyman & Sons, Ltd. Lith. 63, Carter Lane 3382 11.98.

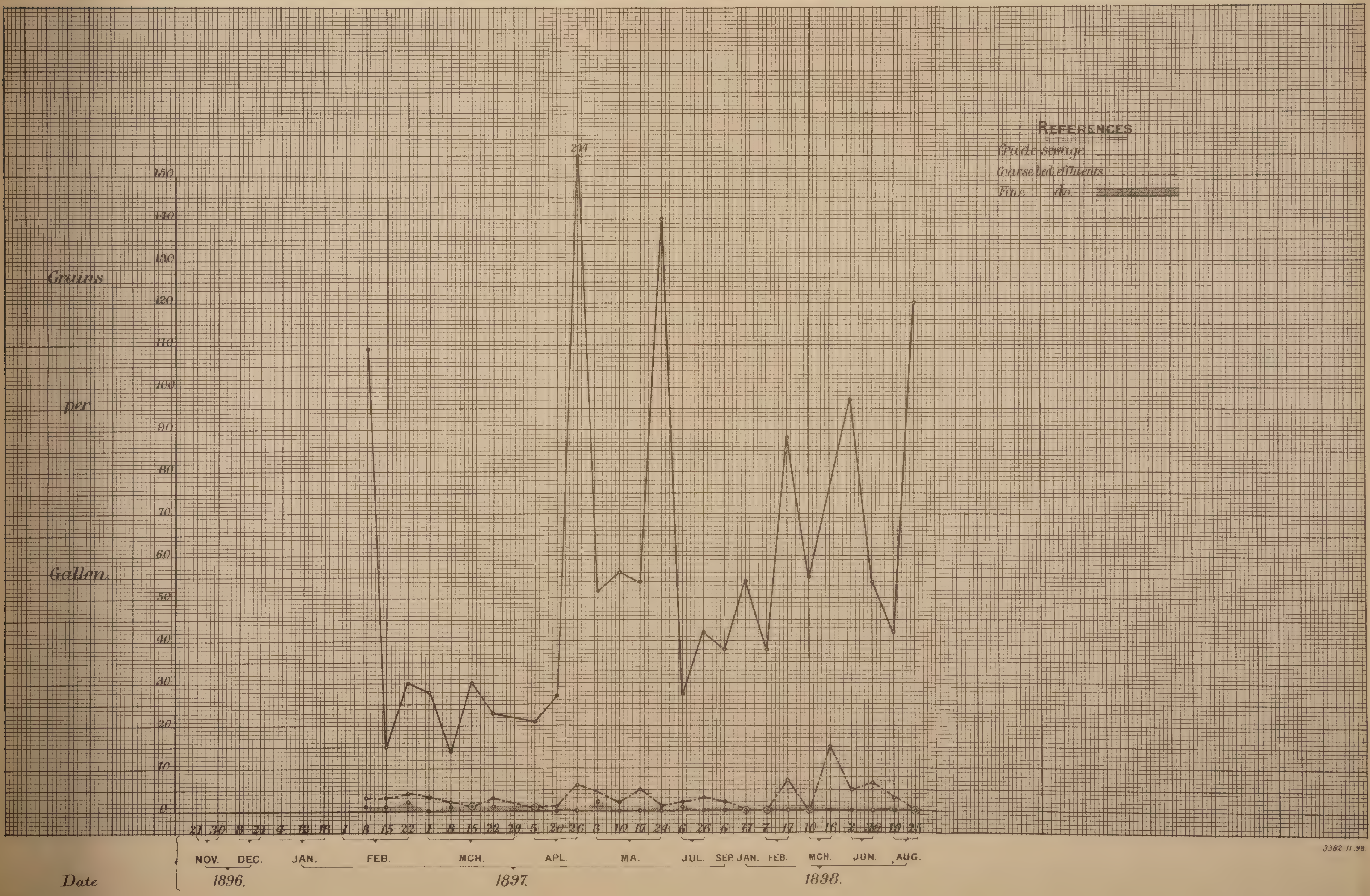
Appendix No. 15.

F. I.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Sutton, Surrey.

SUSPENDED MATTERS.



3382. 11. 98.

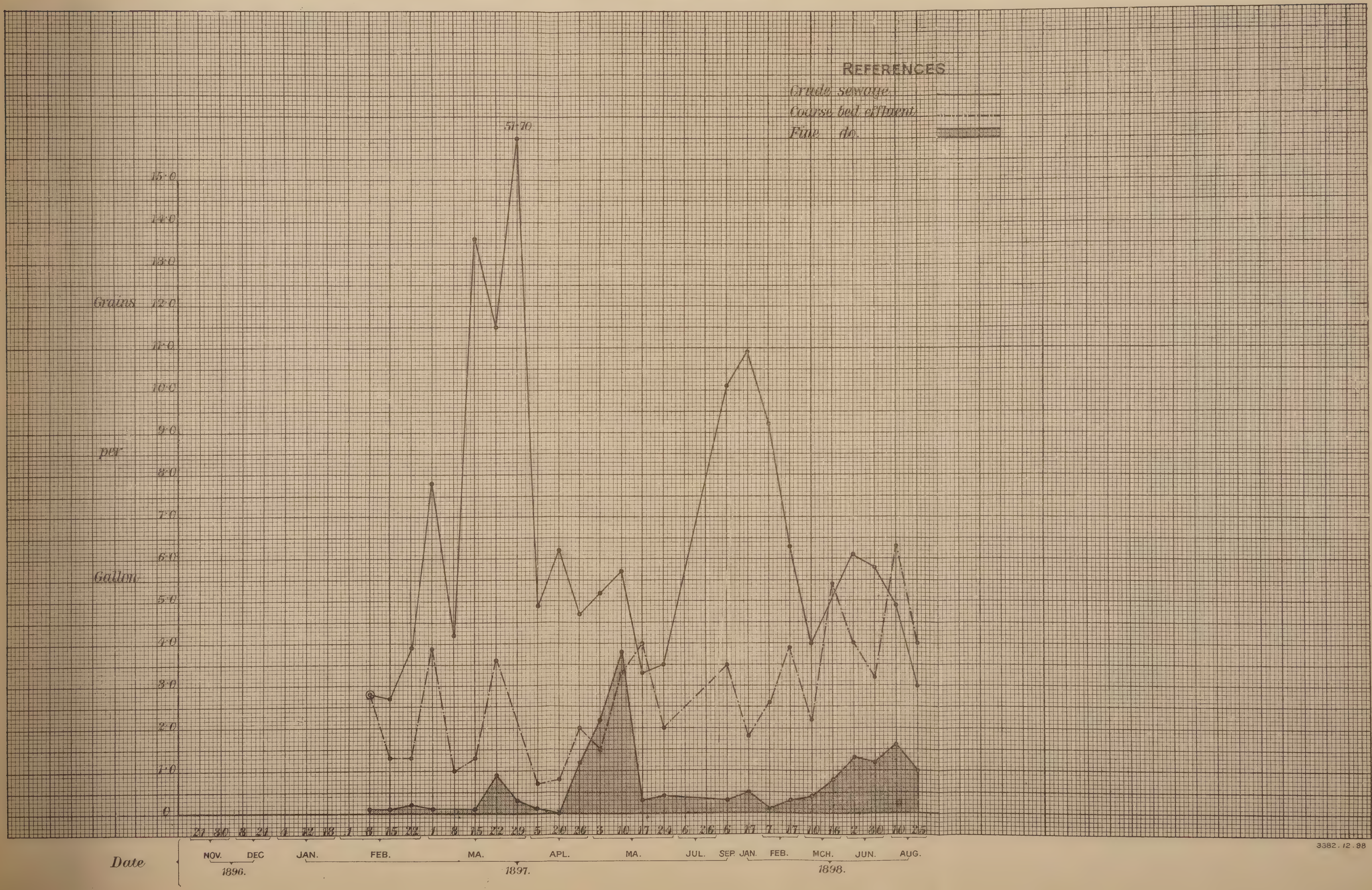
Appendix No. 15.

F. 2.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Sutton, Surrey.

FREE AMMONIA.



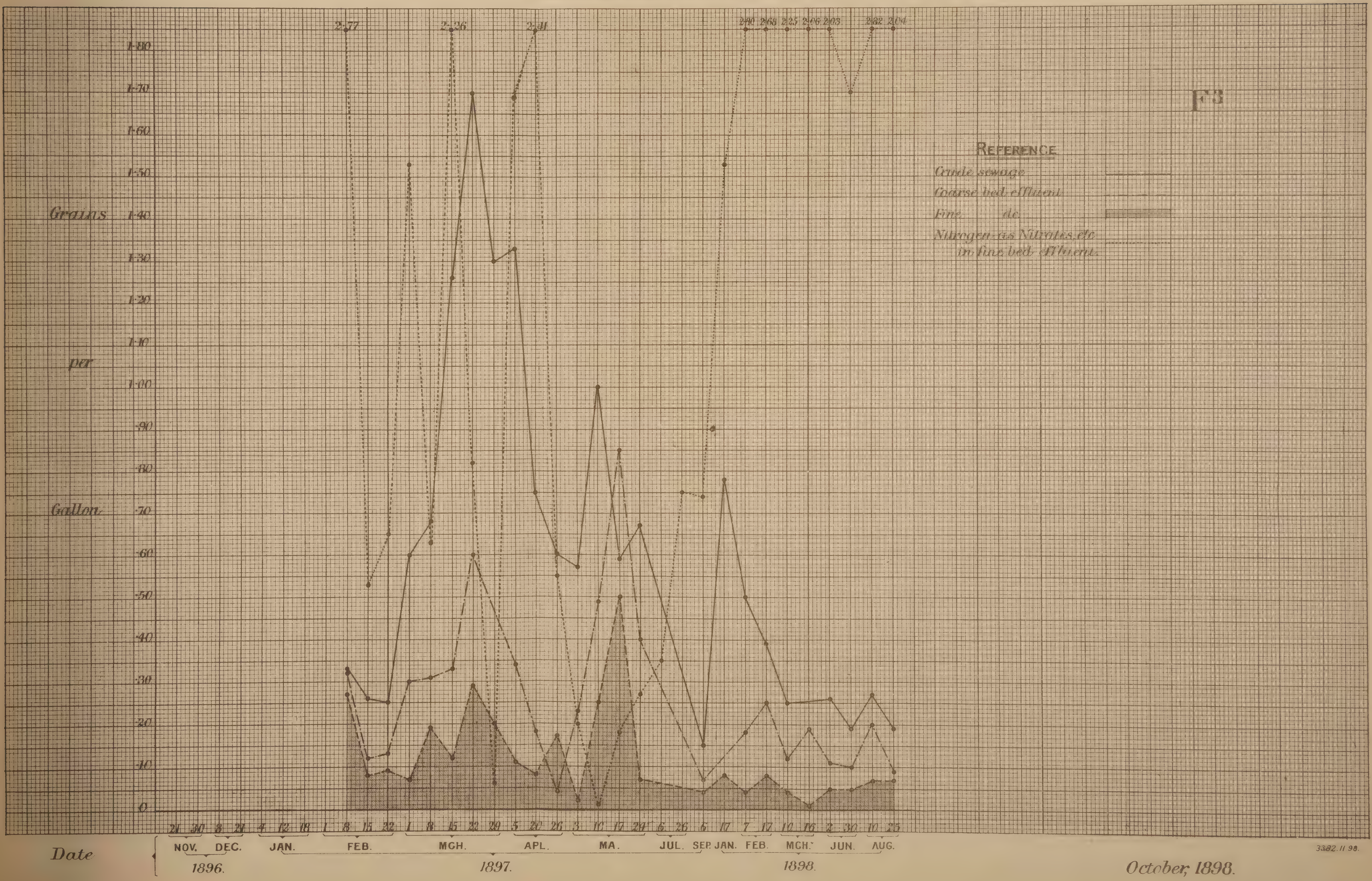
Appendix Nº 15.

F.3.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of the Sewage at Sutton, Surrey.

ALBUMINOID AMMONIA.



3382. 11. 98.

October, 1898.

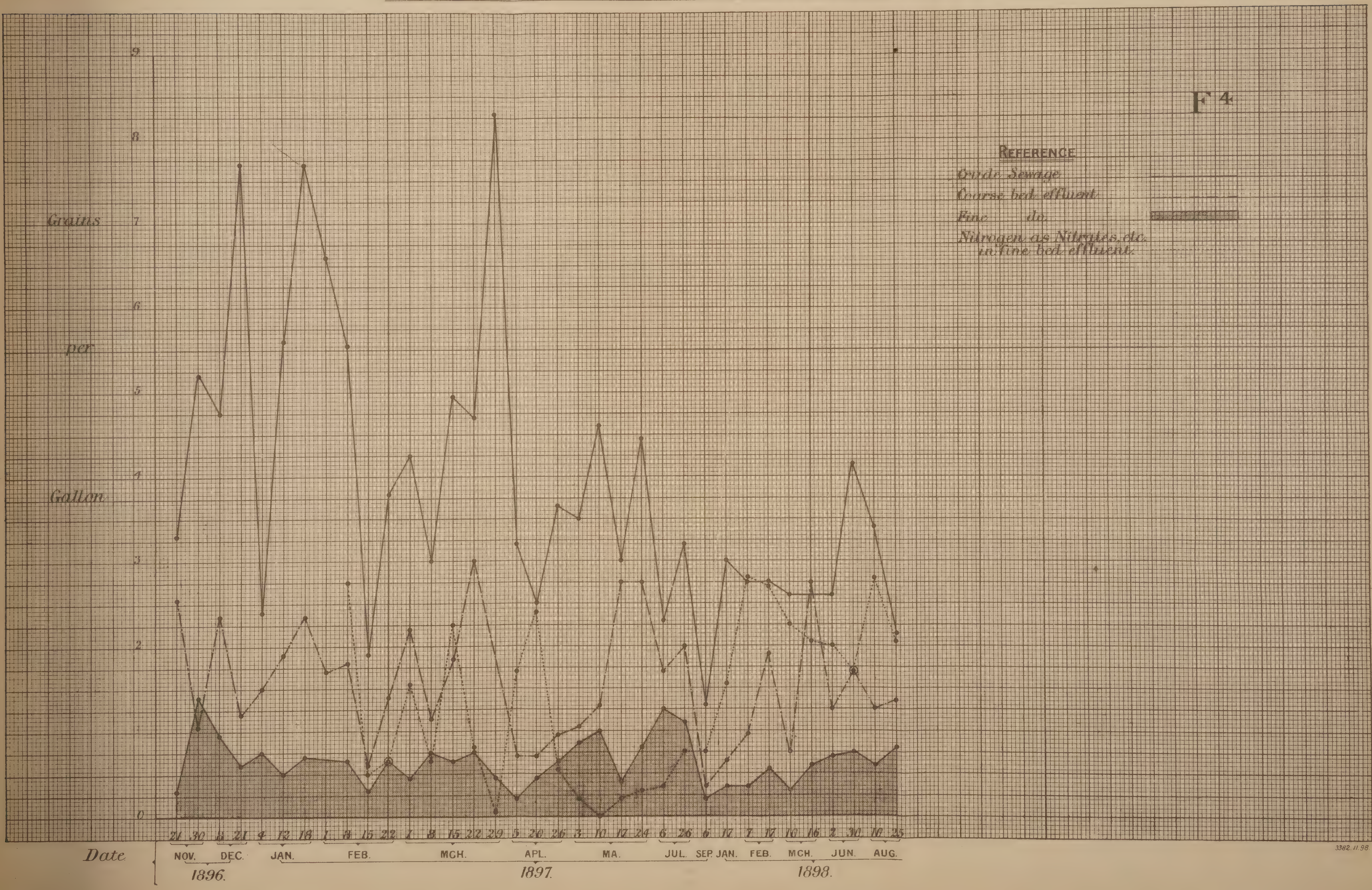
Appendix N° 15.

F.4.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Sutton, Surrey.

OXYGEN ABSORBED IN FOUR HOURS AT 80° F.



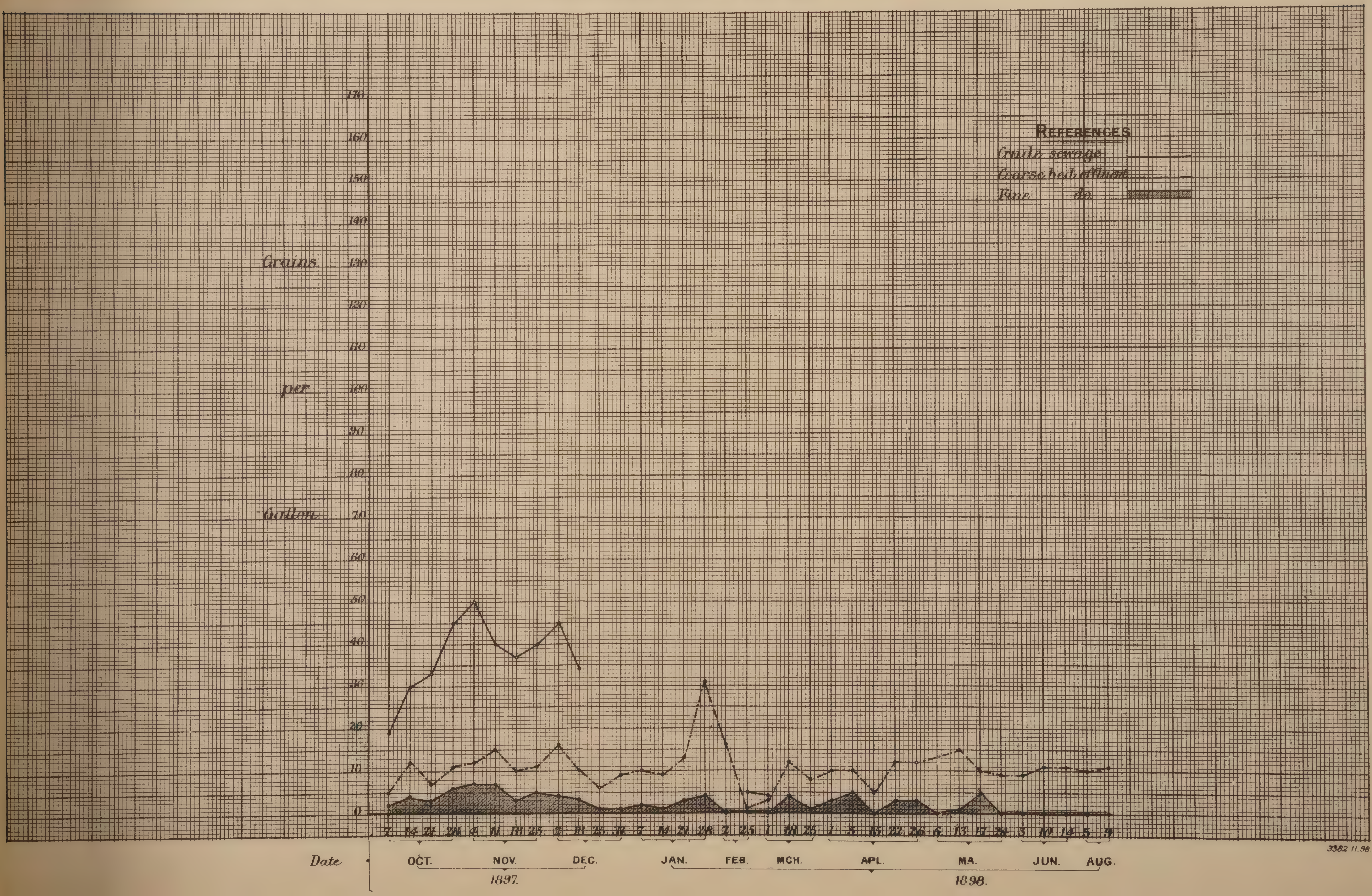
Appendix No. 15.

G. I.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Weekly Average Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Leeds.

SUSPENDED MATTERS.



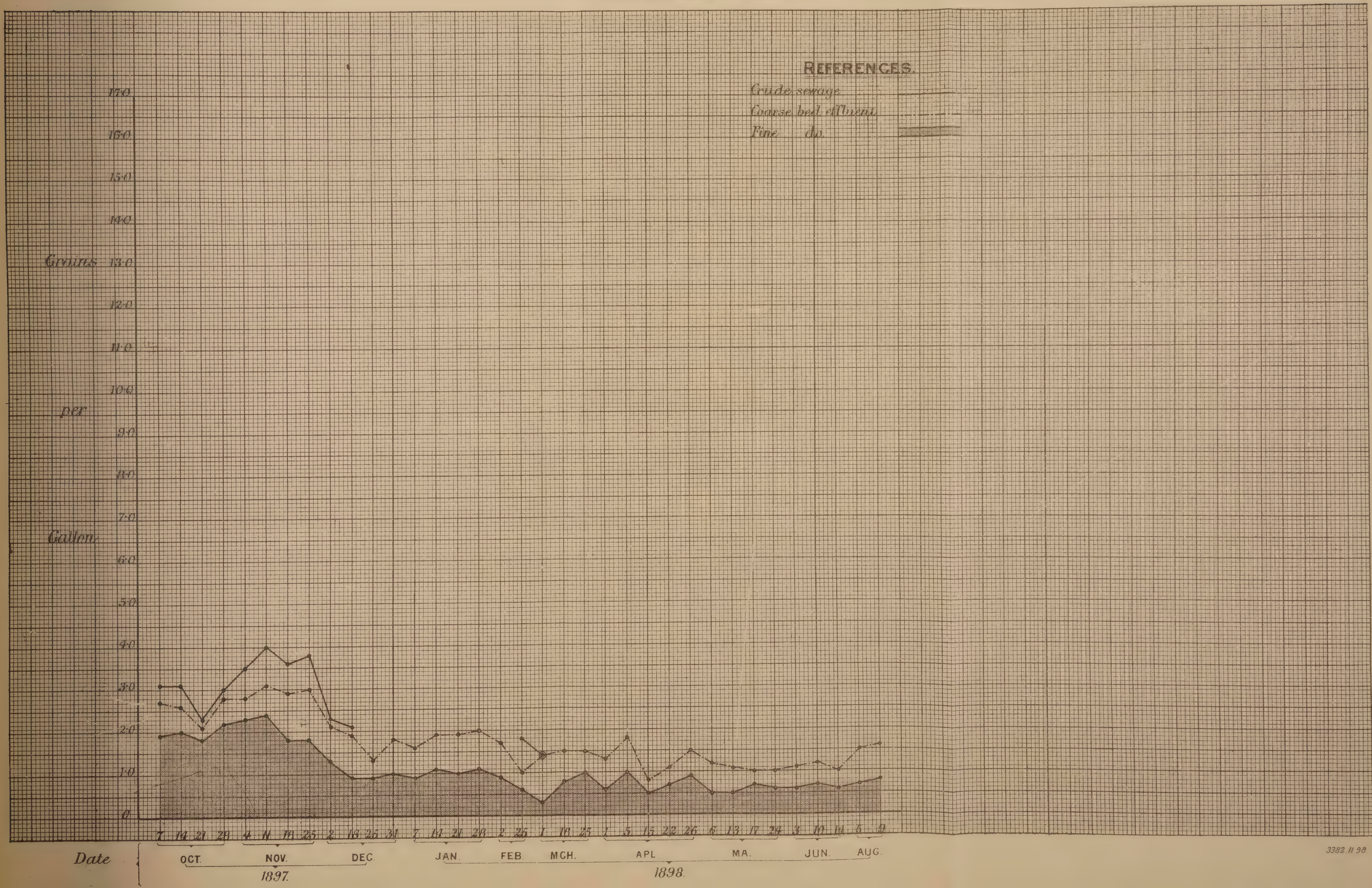
Appendix No. 15.

G. 2.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Weekly Average Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Leeds.

FREE AMMONIA.



3382. 11. 98.

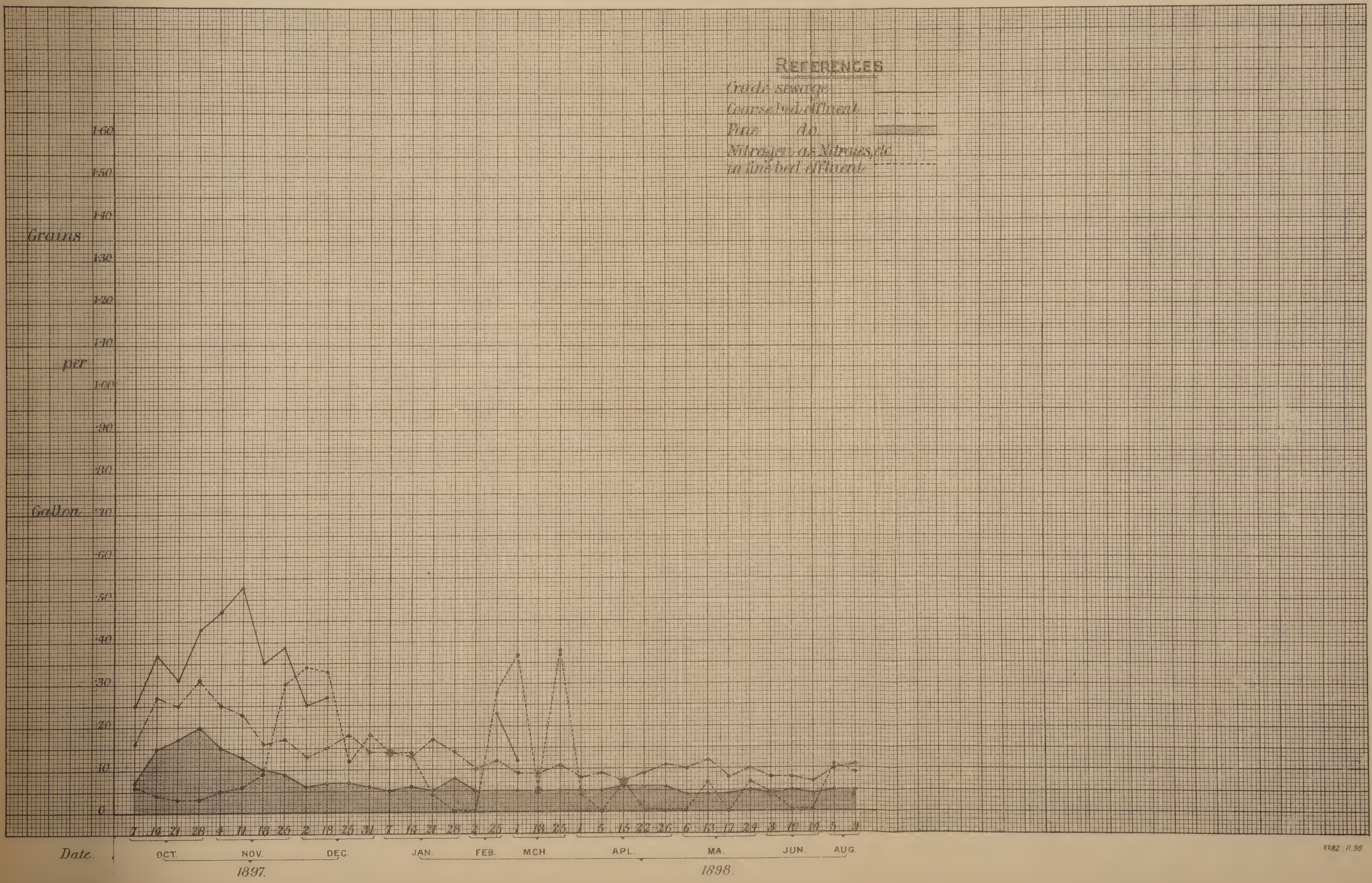
Appendix No. 15.

G. 3.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Weekly Average Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Leeds.

ALBUMINOID AMMONIA.



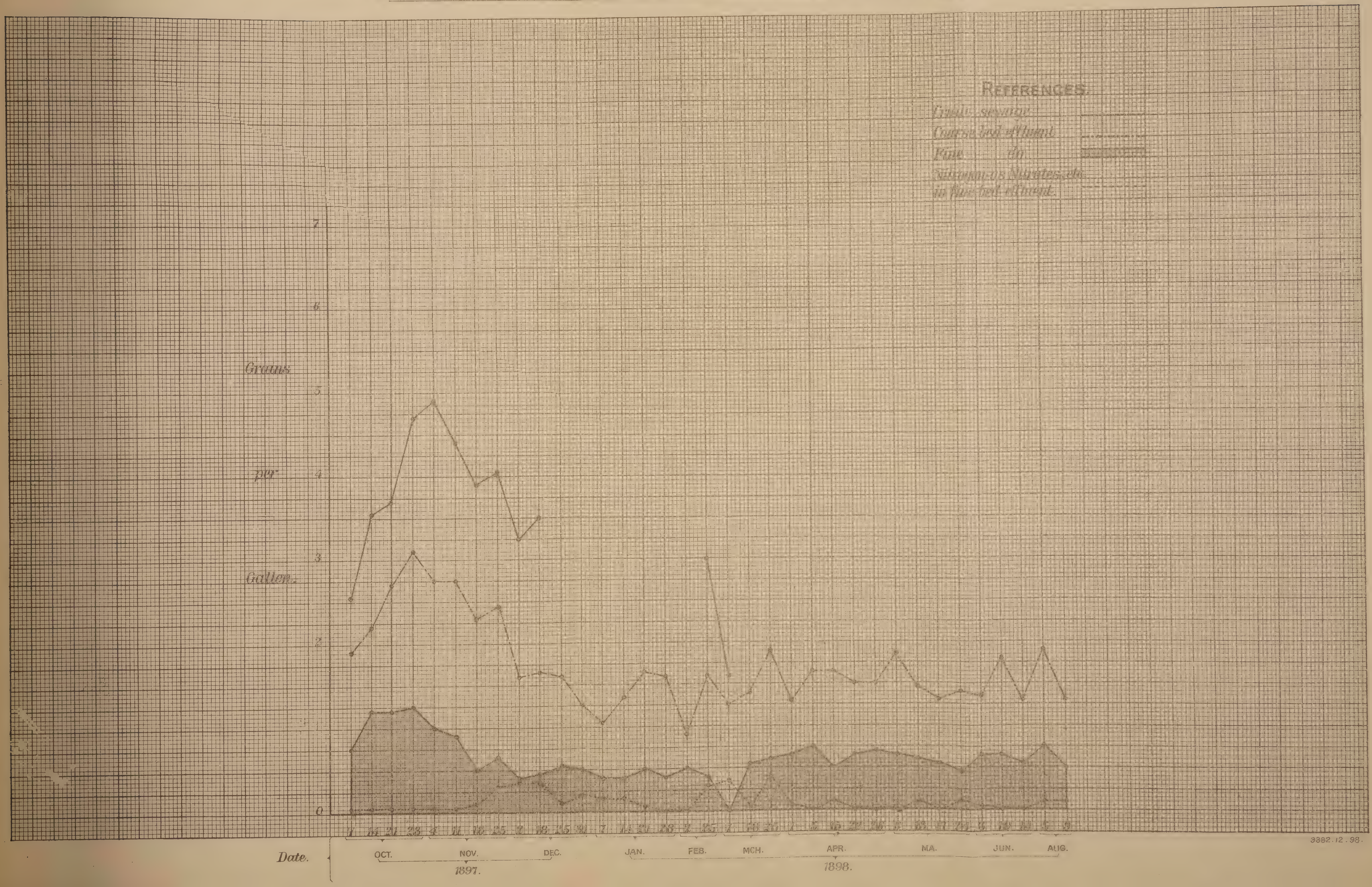
Appendix No. 15.

G. 4.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Weekly Average Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Leeds.

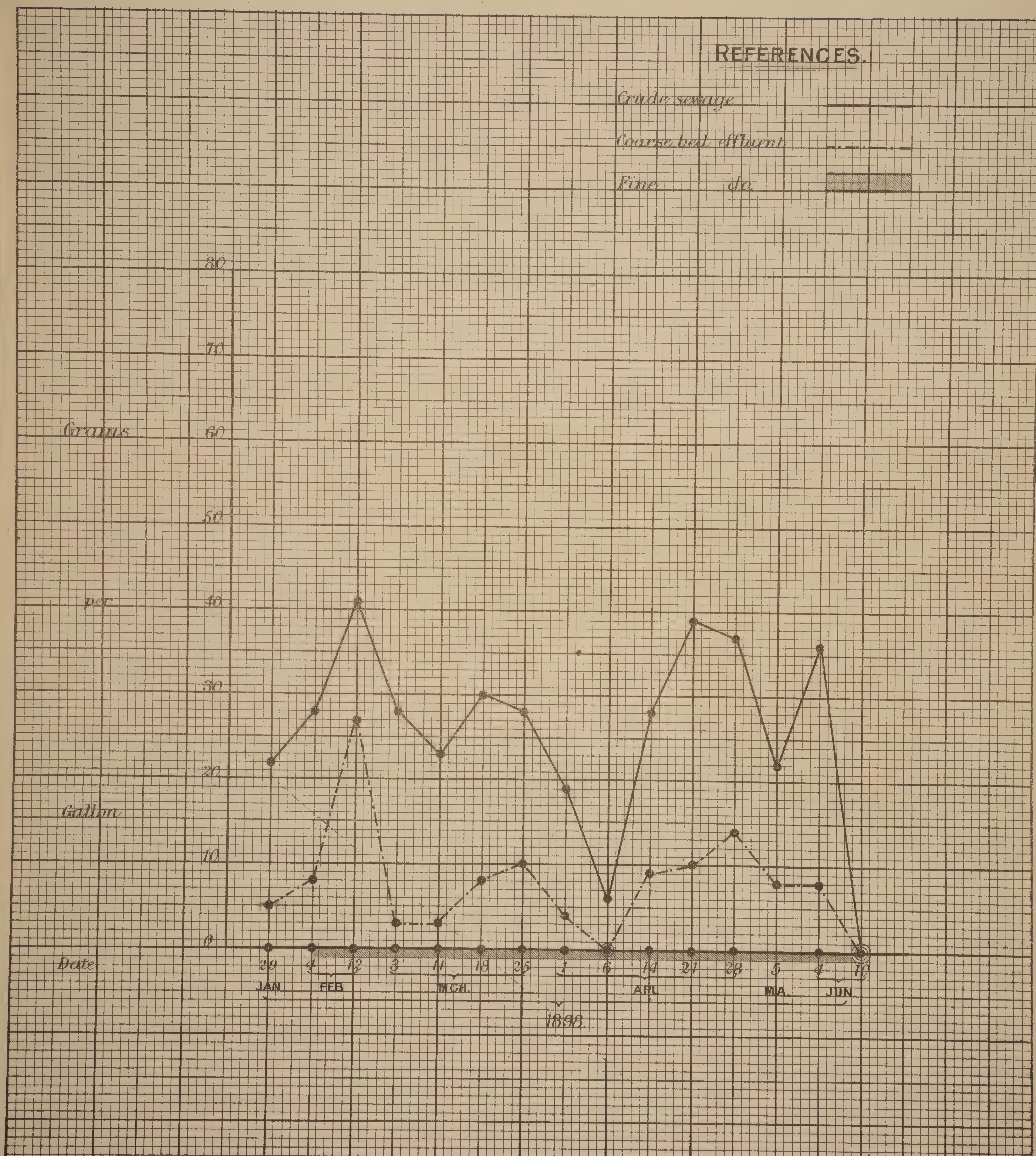
OXYGEN ABSORBED IN 4 HOURS AT 80° F.



H. I.

Diagram to accompany Evidence of Mr. W. J. Dibdin.
Showing the Weekly Average Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Aylesbury.

SUSPENDED MATTERS.



Wyman & Sons, Ltd. Lith, 63, Carter Lane 3382.11.98.

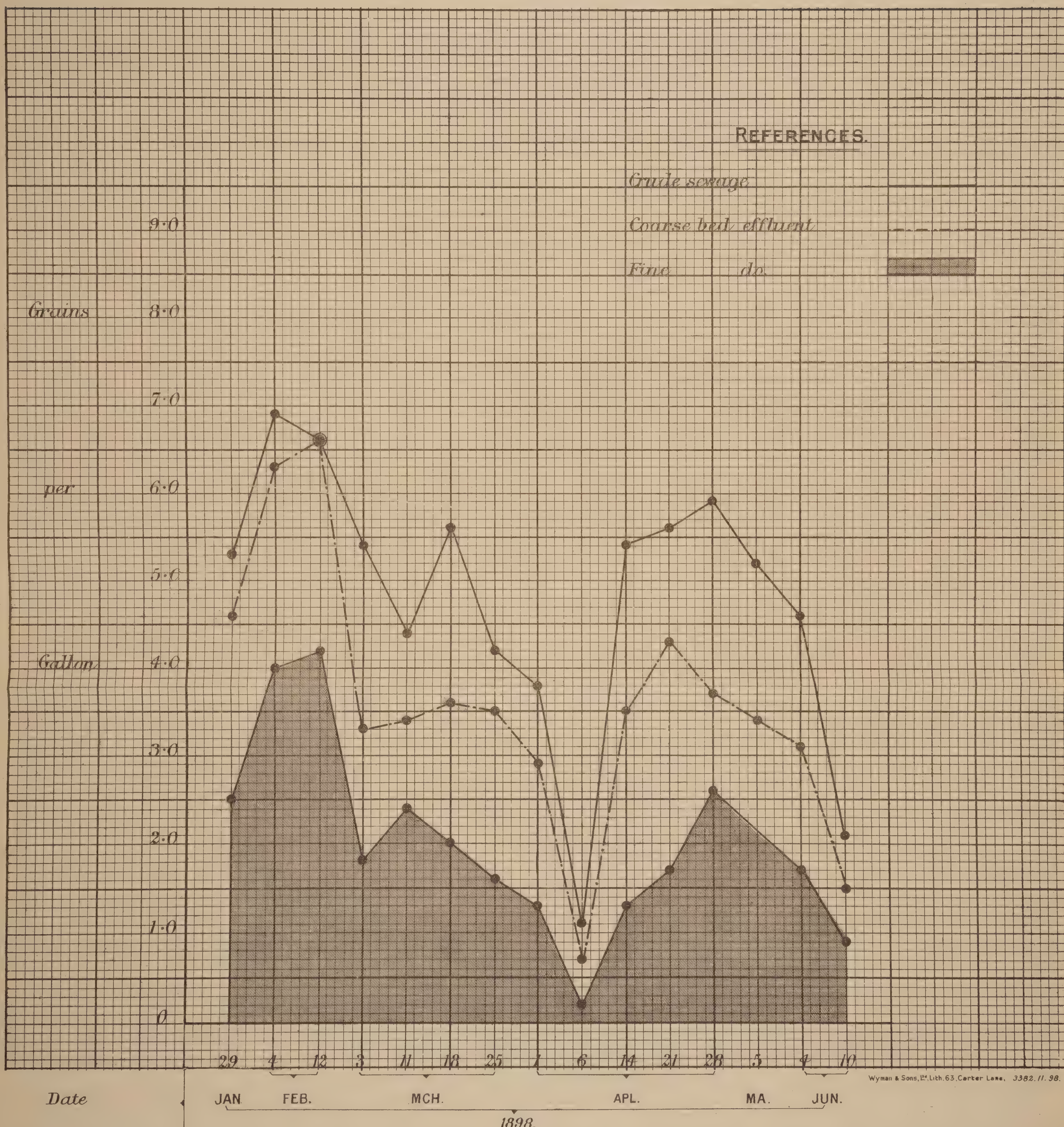
Appendix No. 15.

H.2.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Weekly Average Results of Analyses of Samples of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Aylesbury.

FREE AMMONIA.



Wyman & Sons, Ltd. Lith. 63, Carter Lane. 3382. 11. 98.

H. 3.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Weekly Average Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Aylesbury.

ALBUMINOID AMMONIA.

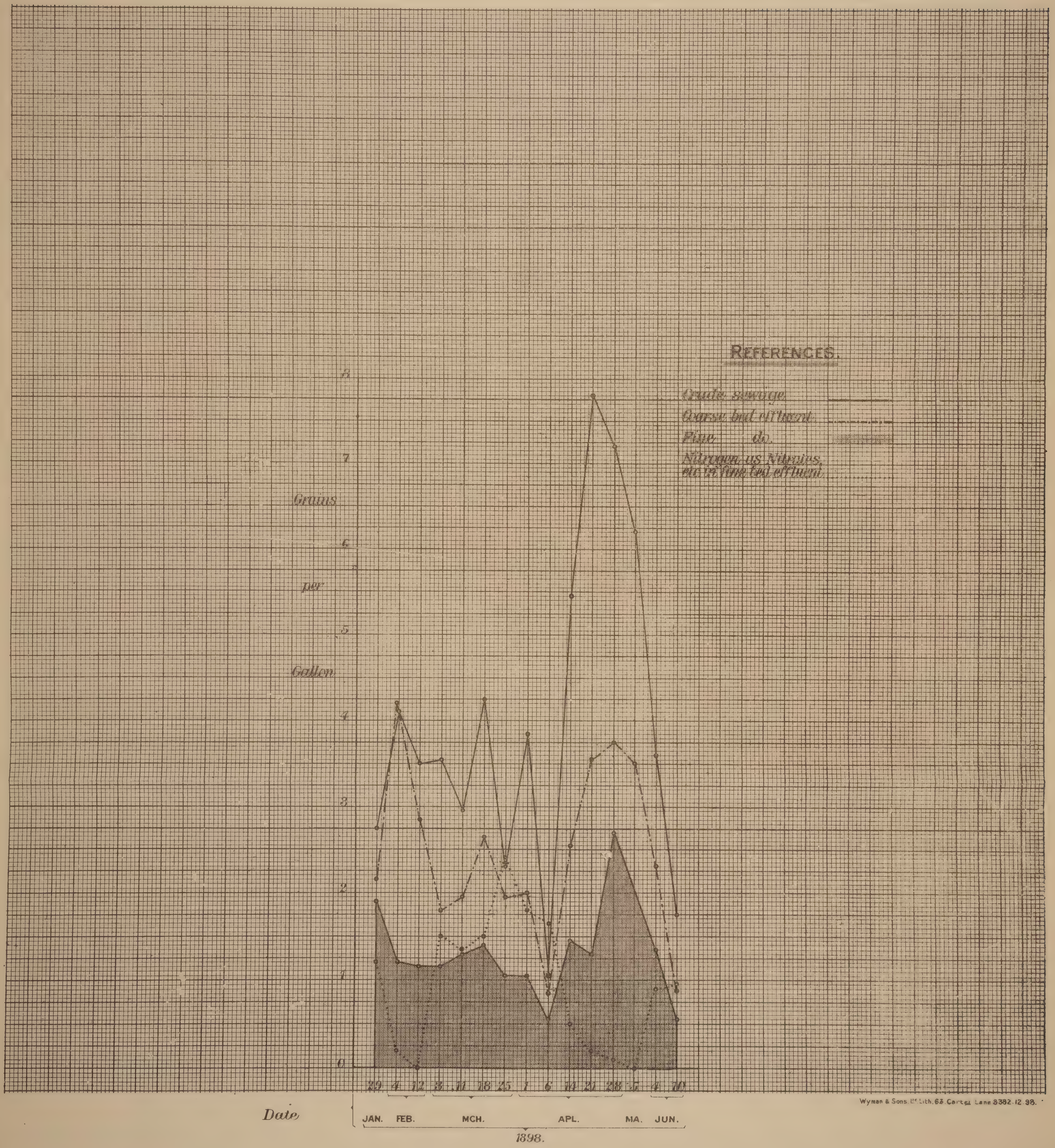
Wyman & Sons, Ld. Lith 63 Carter Lane. 3382. 11. 98.

H.4.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Weekly Average Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Aylesbury.

OXYGEN ABSORBED IN 4 HOURS AT 80°. F.



Wyman & Sons, Ltd. Lith. 63 Carter Lane 8382. 12. 98.

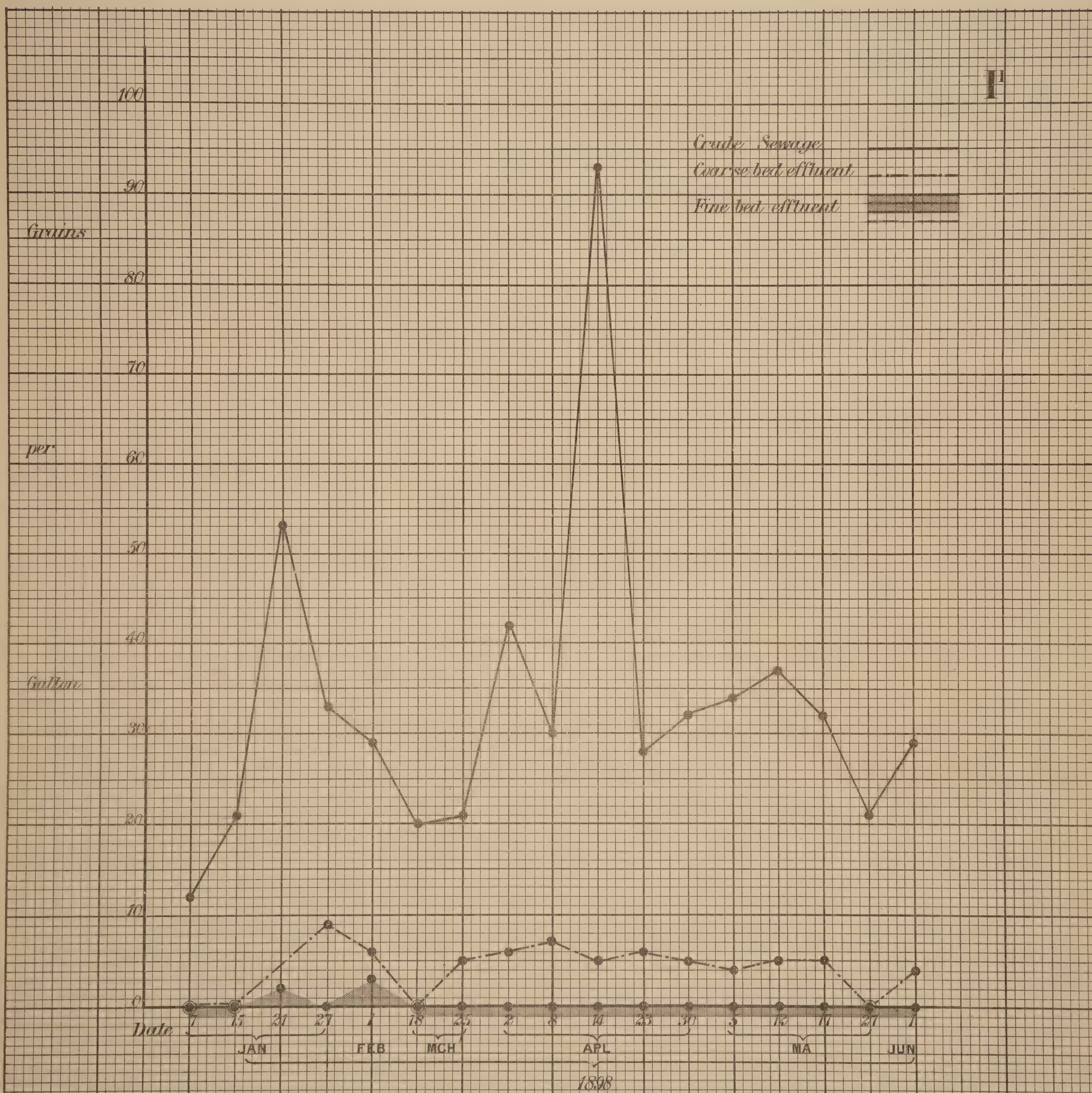
Appendix No. 15.

I. 1.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Weekly Average Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Blackburn.

SUSPENDED MATTERS.



3382. 11. 98.

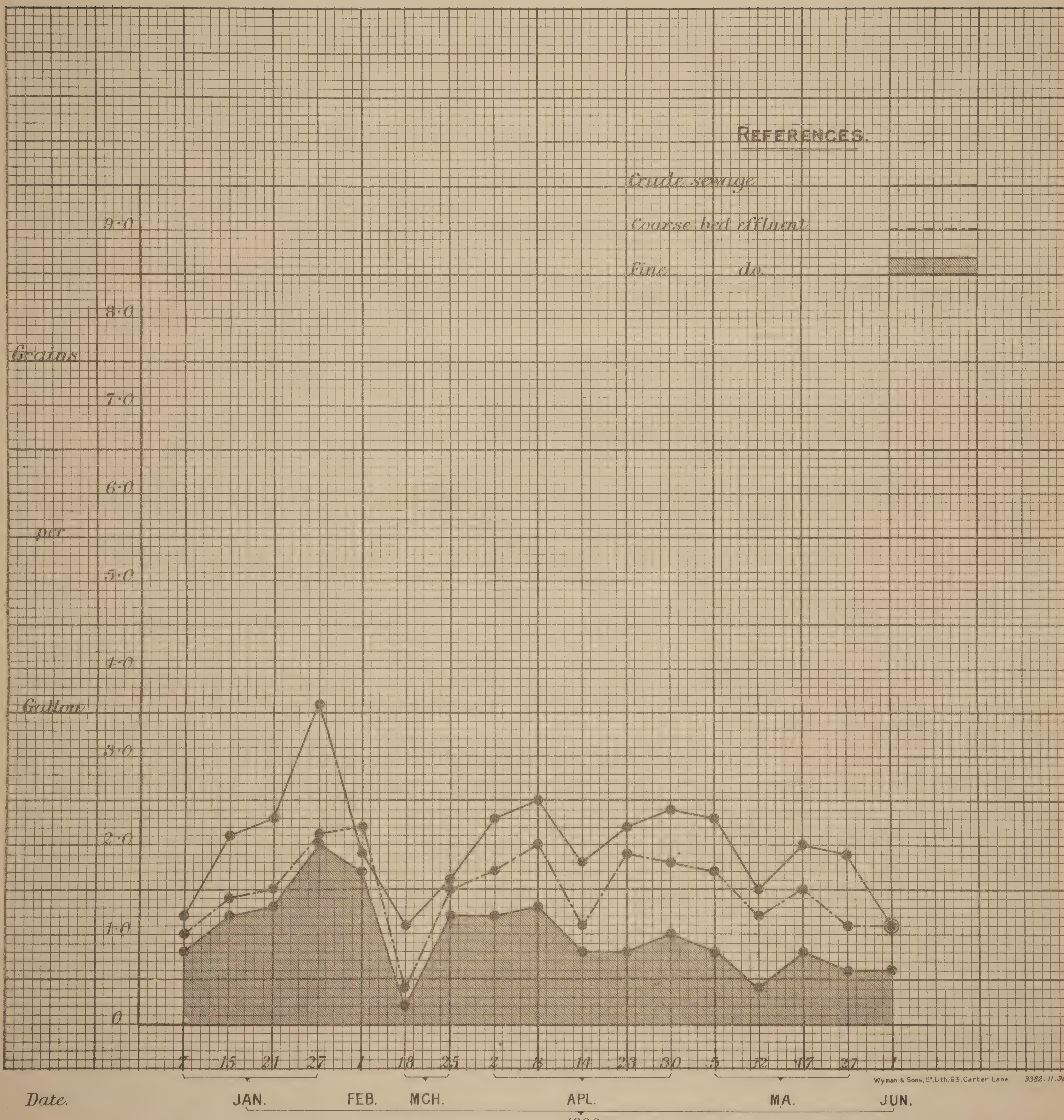
Appendix No. 15.

I.2.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Weekly Average Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Blackburn.

FREE AMMONIA.



Wyman & Sons, Ltd. Lith. 63, Carter Lane 3382. 11. 98.

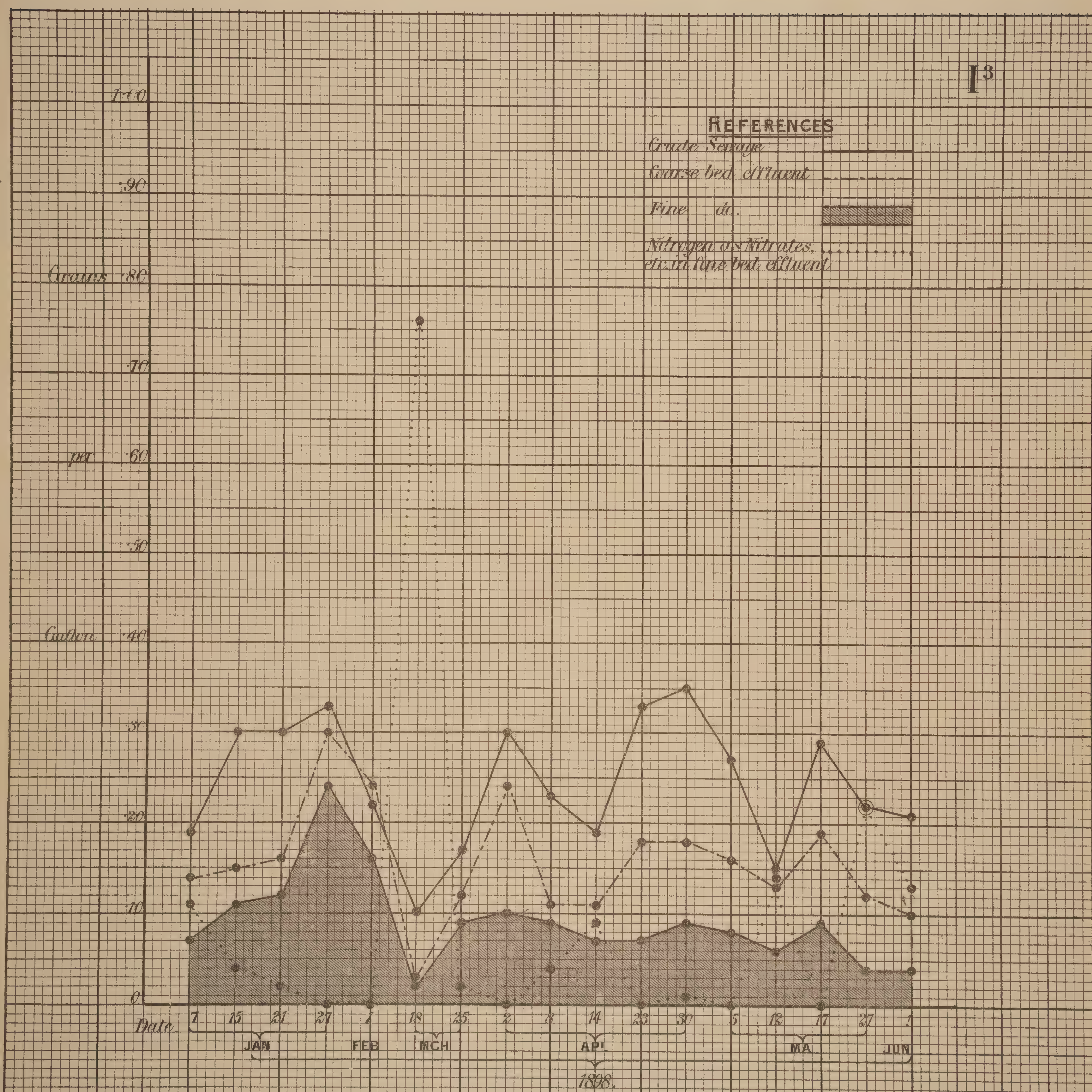
Appendix Nº 15.

I. 3.

Diagram to accompany Evidence of Mr W. J. Dibdin.

Showing the Weekly Average Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Blackburn.

ALBUMINOID AMMONIA



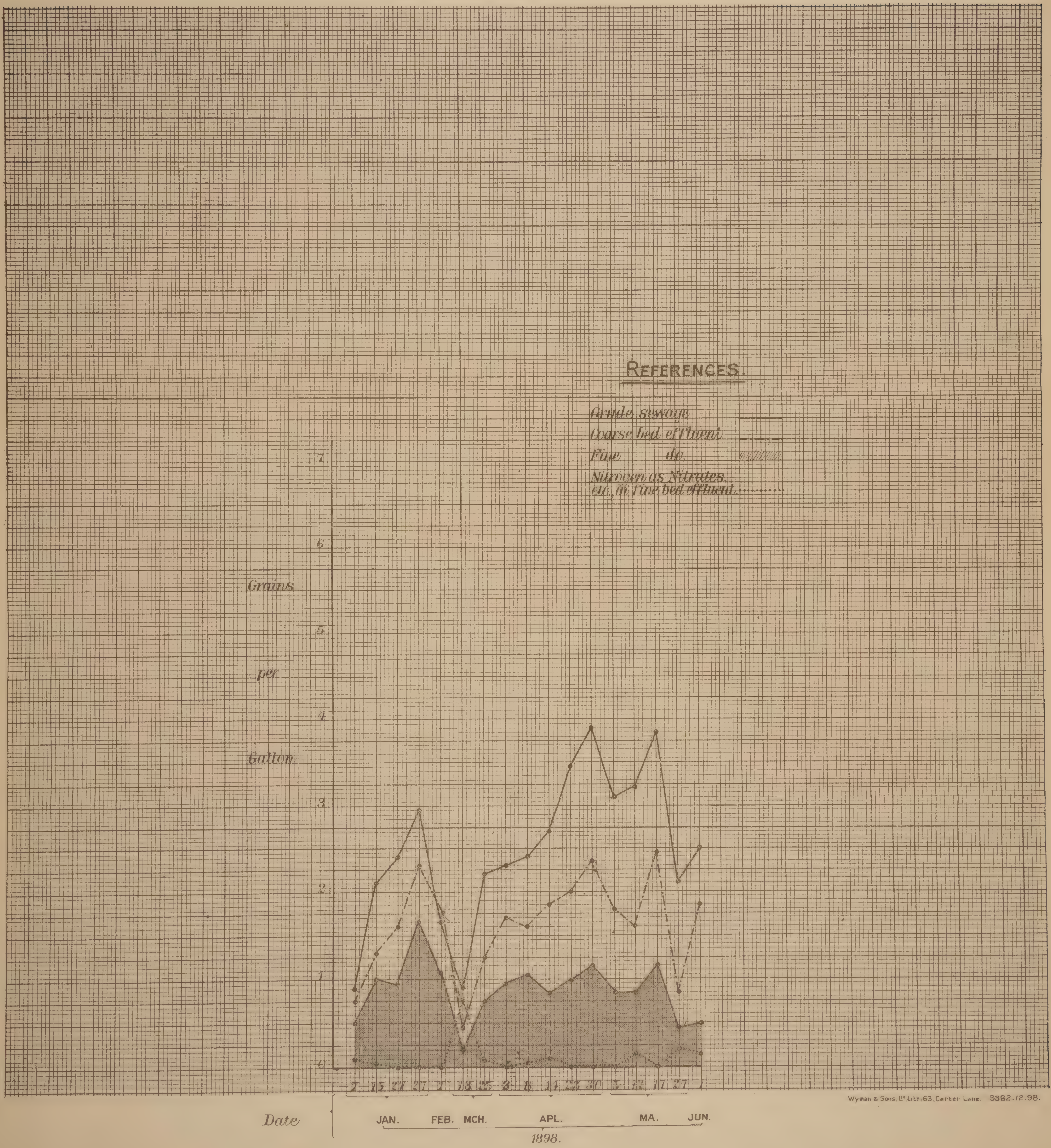
3382.. 11.98.

1.4.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing the Weekly Average Results of Analyses of Sewage and Effluents obtained by the Bacterial Treatment of Sewage at Blackburn.

OXYGEN ABSORBED IN 4 HOURS AT 80° F.



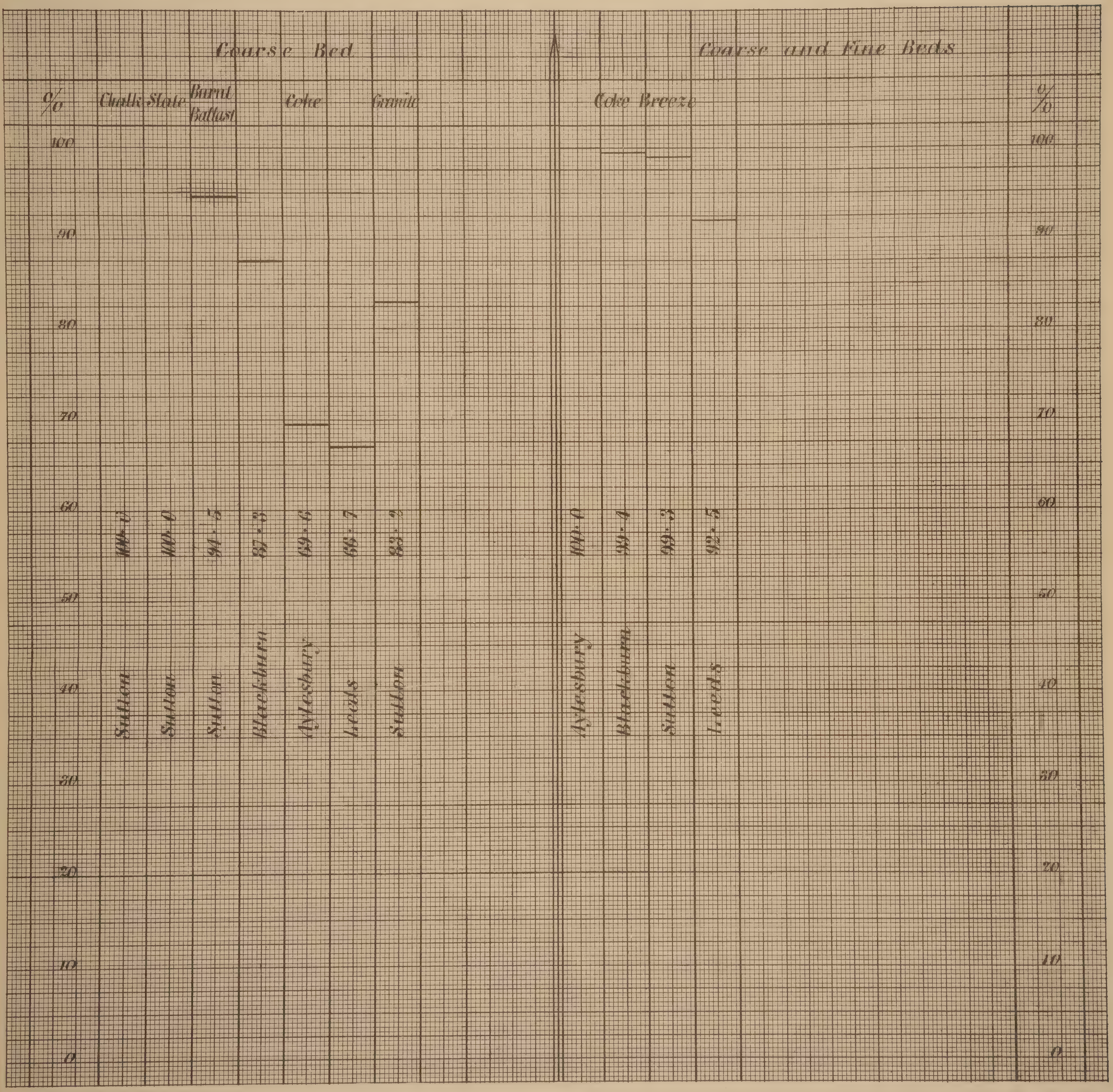
Wyman & Sons, Ld. Lith. 63, Carter Lane. 3382. 12. 98.

Appendix No. 15.

J.I.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing Percentage of Purification obtained by the use of Various Bed Materials at different Towns.
Calculated on Suspended Matters.



3382.10.98

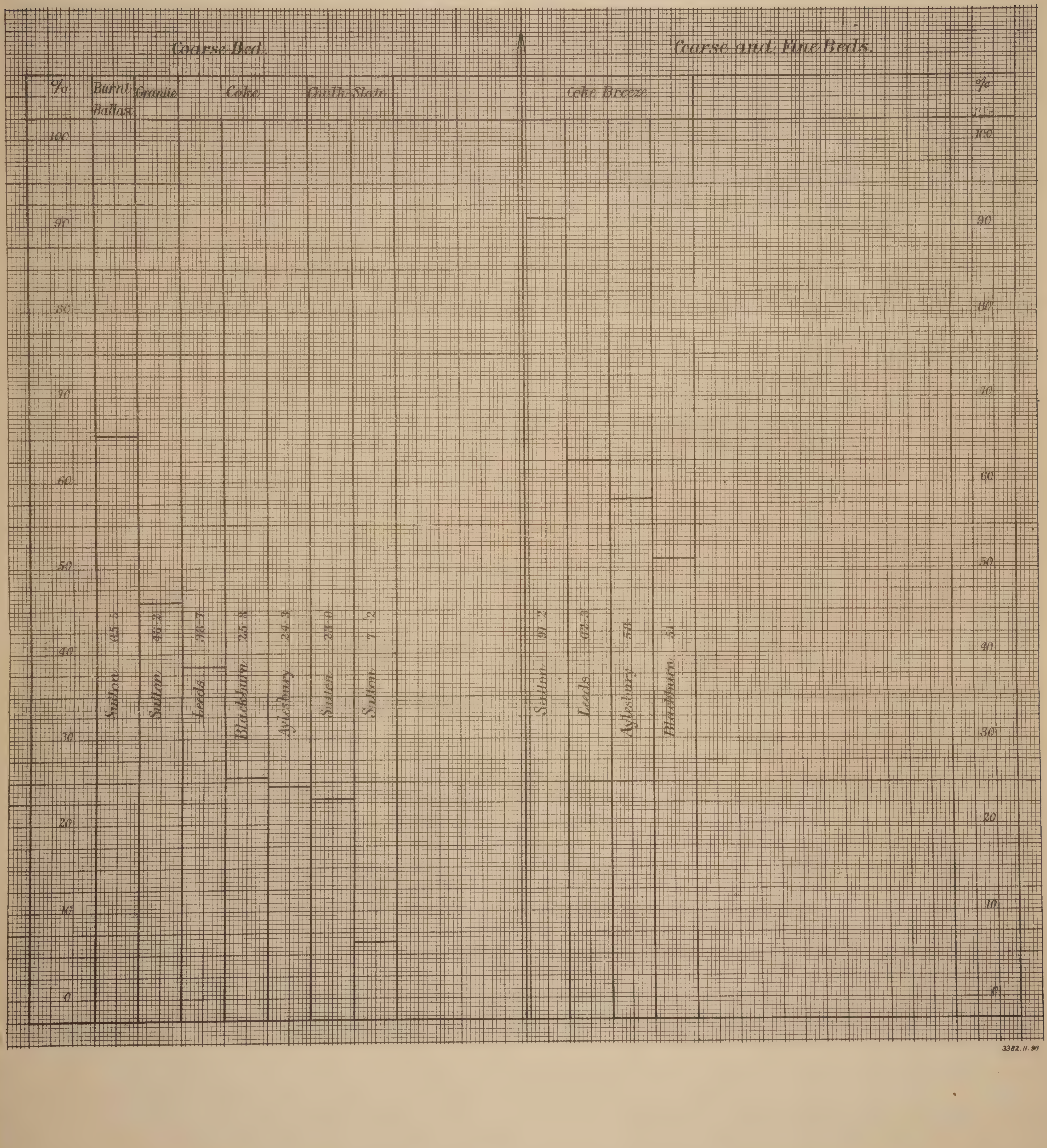
Appendix No. 15.

J.2.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing Percentage of Purification obtained by the use of Various Bed Materials at different Towns.

CALCULATED ON FREE AMMONIA.



3382. 11. 96

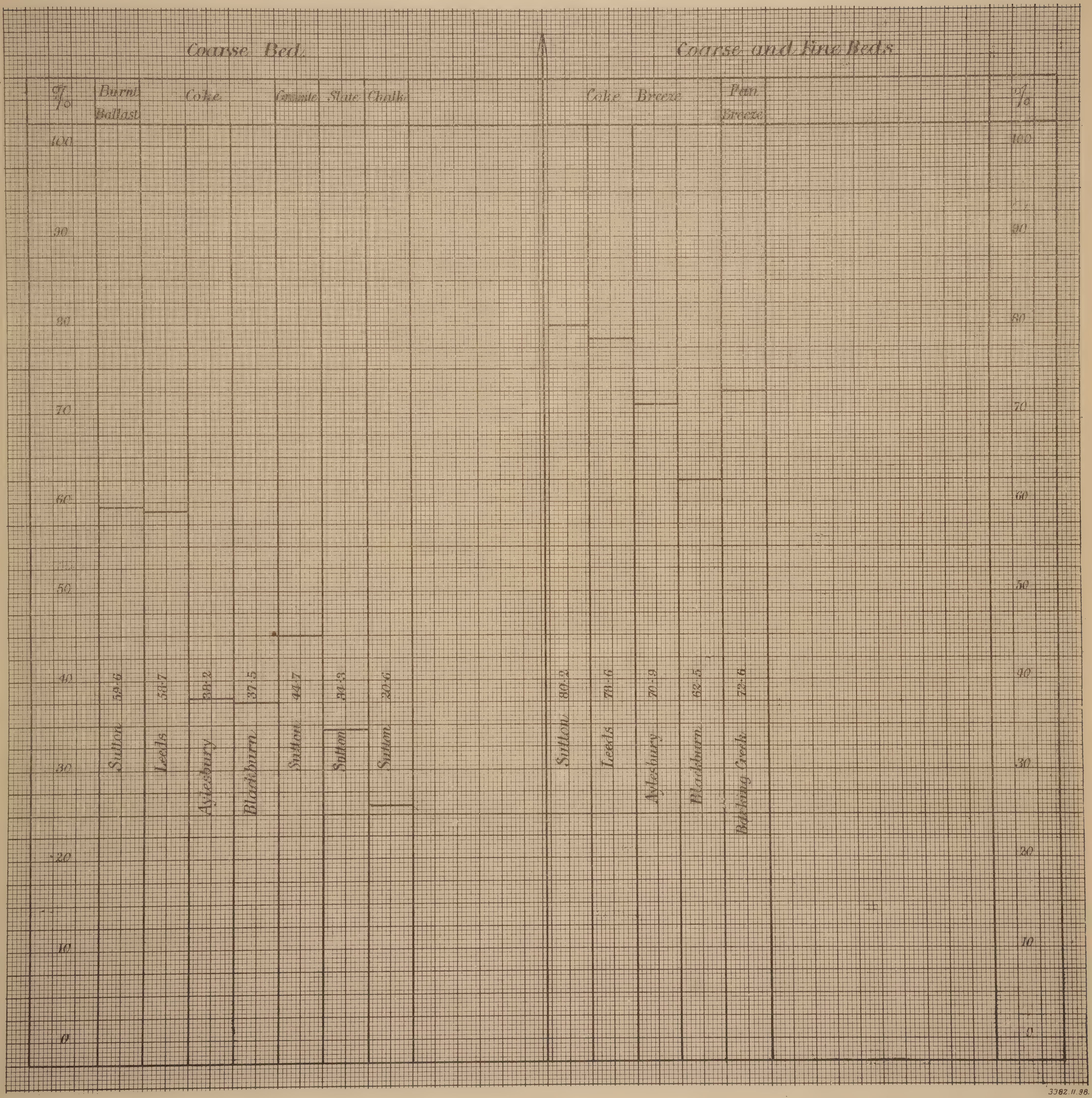
Appendix No. 15.

J. 3.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing Percentage of Purification obtained by the use of Various Bed Materials at different Towns.

CALCULATED ON ALBUMINOID AMMONIA.



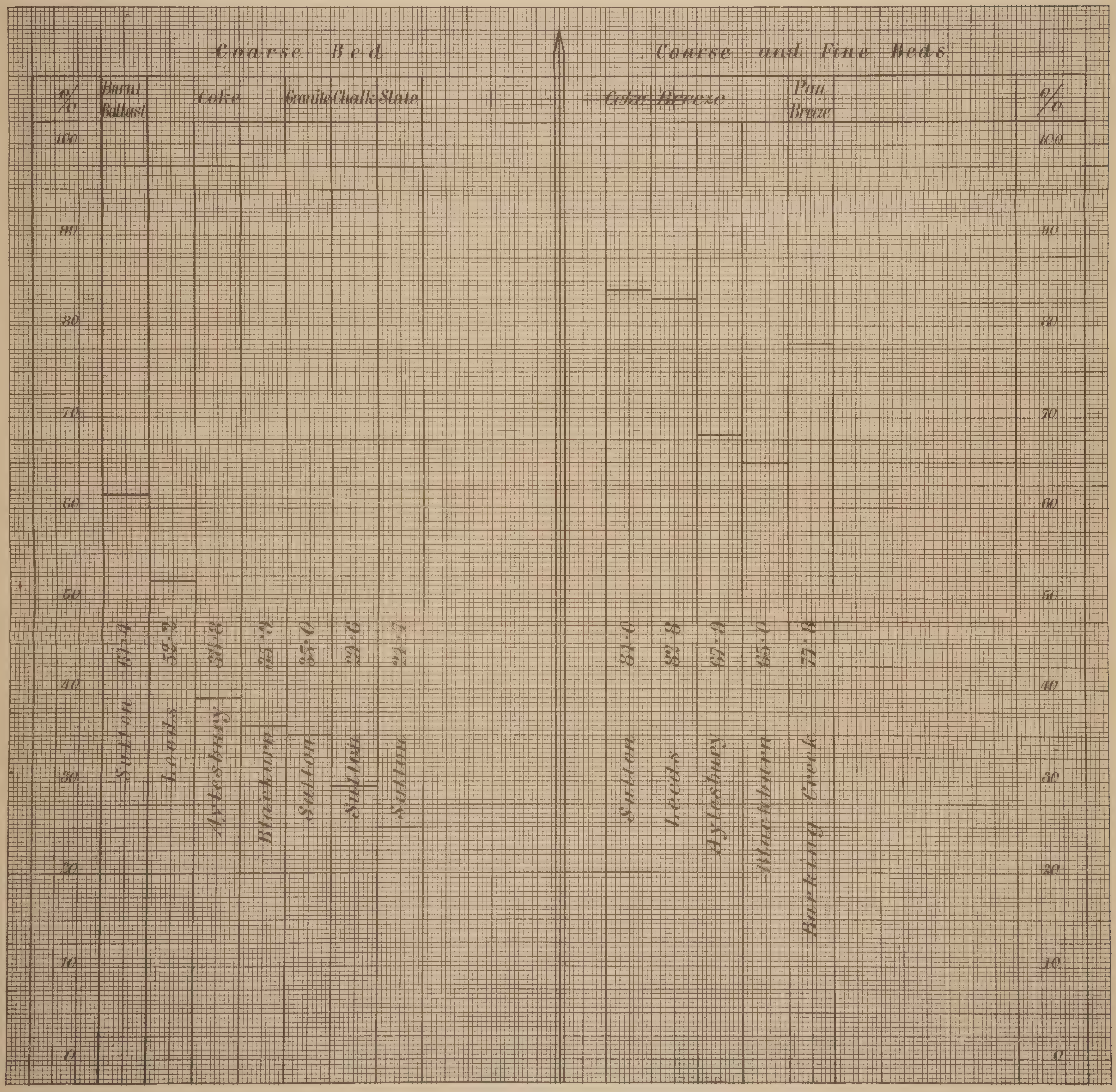
3382. 11. 98.

Appendix No. 15.

J.4.

Diagram to accompany Evidence of Mr. W. J. Dibdin.

Showing Percentage of Purification obtained by the use of Various Bed Materials at different Towns. Calculated on Oxygen absorbed from Permanganate in Four Hours at Eighty Degrees Fahrenheit.



3382 10.98.

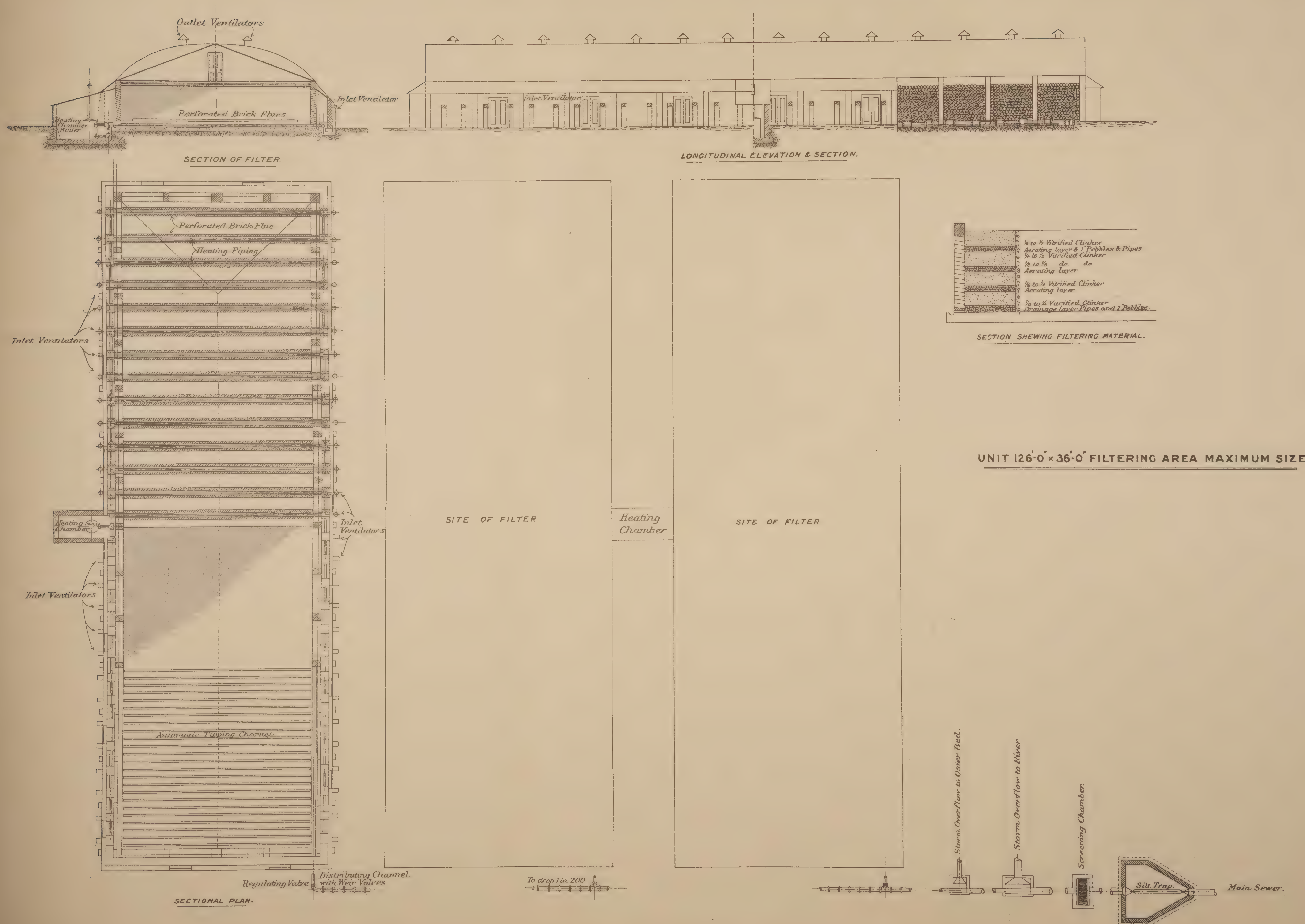
APPENDIX, No. 16.

Appendix No. 16.

Handed in by Col. Ducat.

C

AERATING BACTERIAL SELF ACTING FILTER.



APPENDIX, No. 17.

Appendix No. 17.

Handed in by W. E. Adeney Esq.

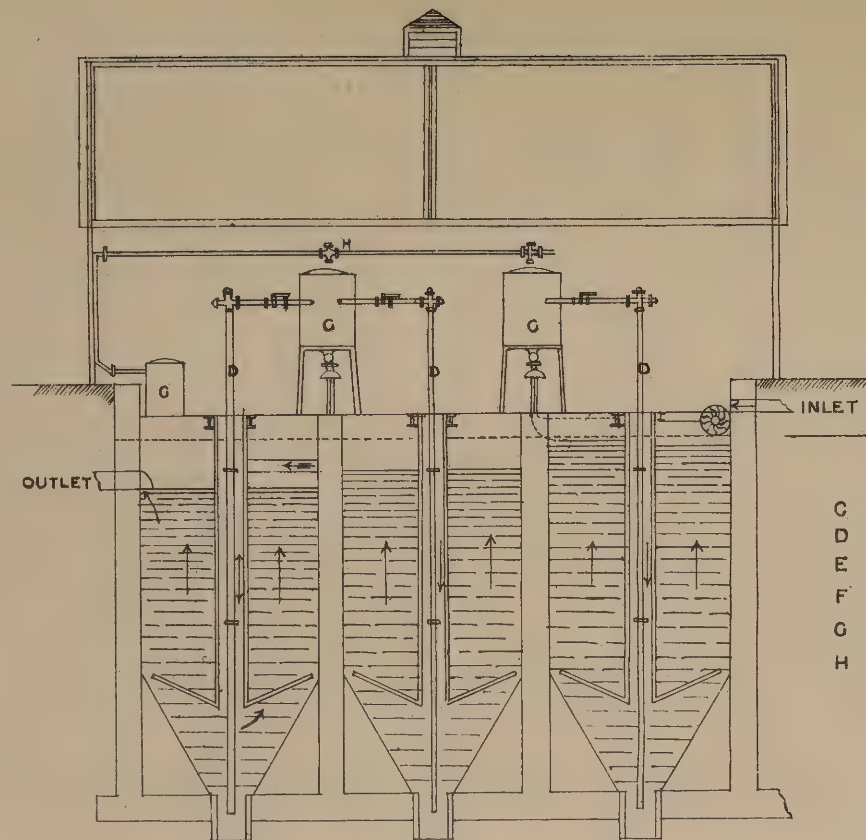
A

DUNDRUM LUNATIC ASYLUM

SEWAGE DISPOSAL WORKS

THE OXYGEN SEWAGE PURIFICATION COMPANY'S PROCESS

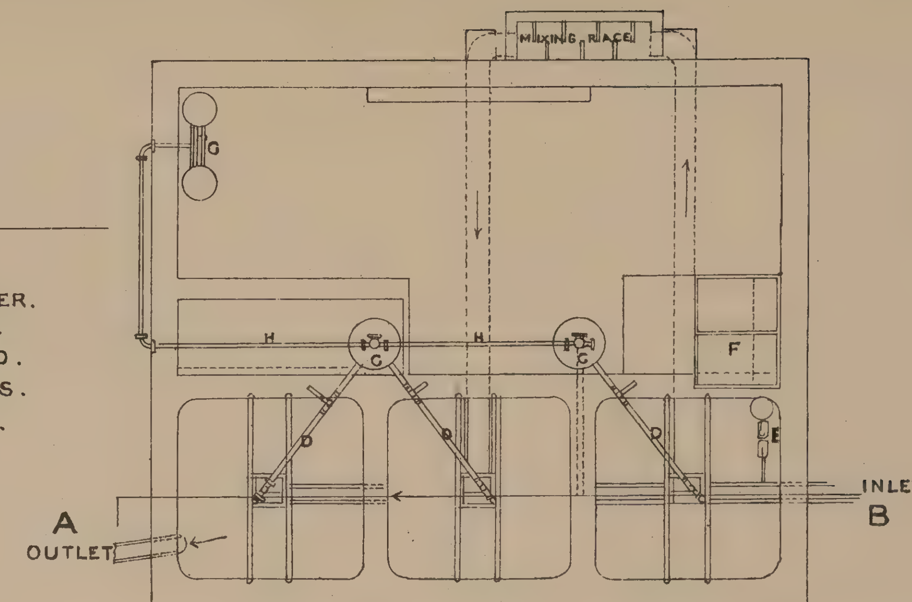
1892.



SECTION AB

REFERENCE

C SLUDGE CYLINDER.
D SUCTION PIPES.
E AUTOMATIC FEED.
F CHEMICAL TANKS.
G VACUUM PUMP.
H " " " PIPE.



PLAN

W. Kaye Parry MA, BE.
35 Dame Street
Dublin.

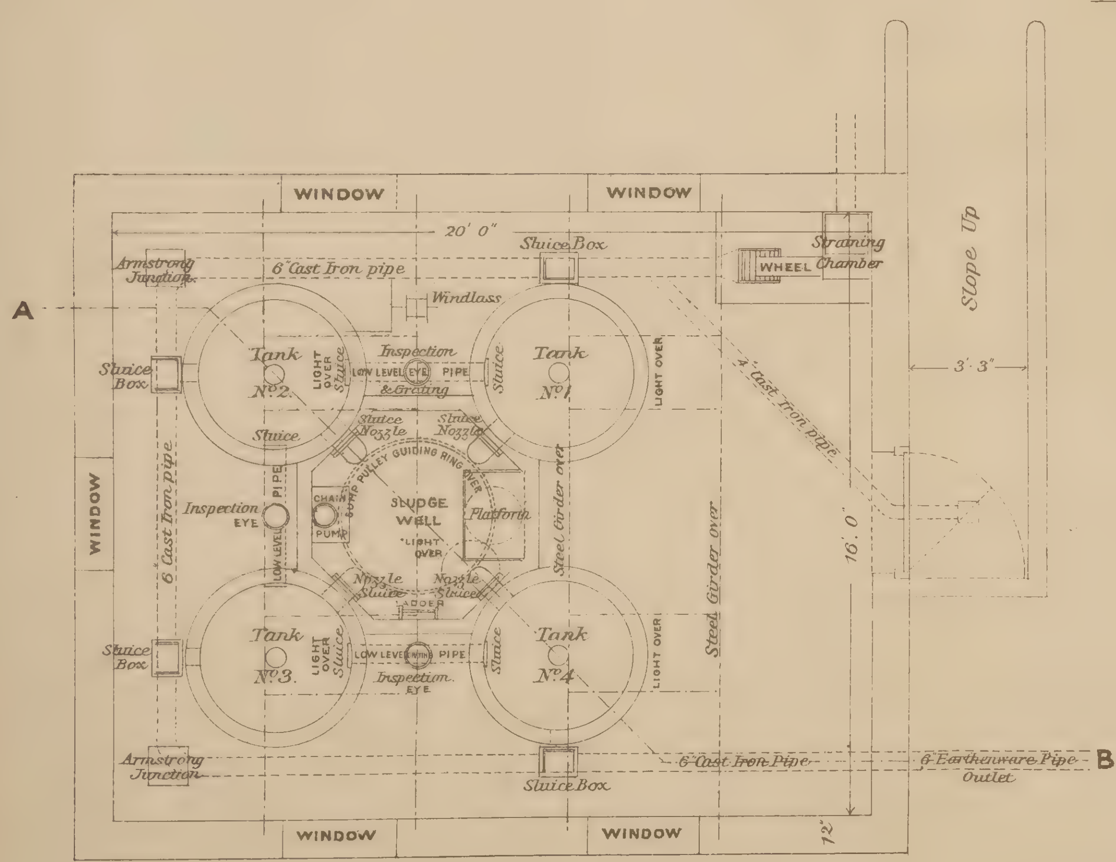
B.

Appendix No. 17. Handed in by W. E. Adeney, Esq.,

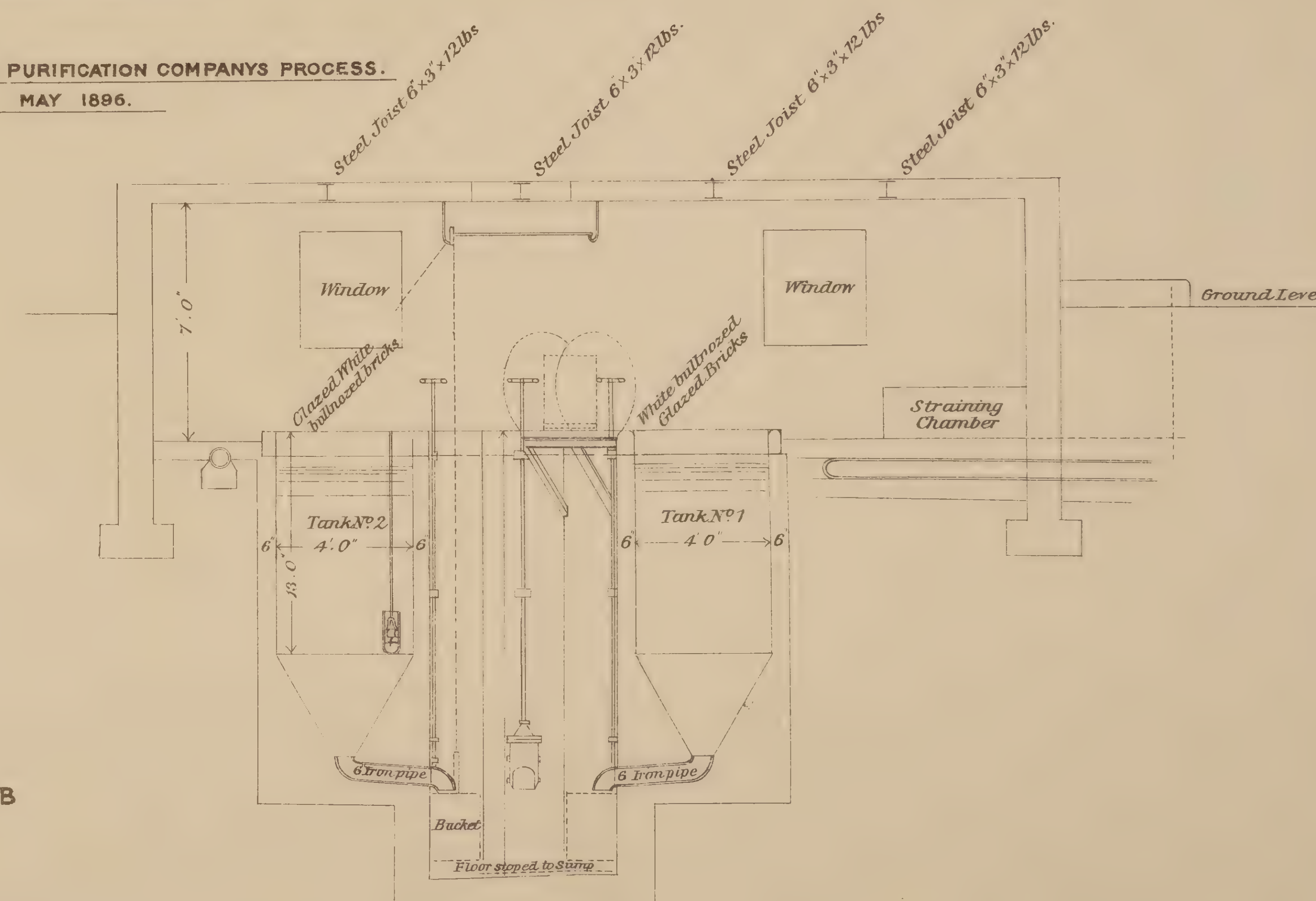
SEWAGE PURIFICATION TANKS.
CHAPELIZOD POLICE BARRACKS.
CO. DUBLIN.

THE OXYGEN SEWAGE PURIFICATION COMPANYS PROCESS.

MAY 1896.



PLAN



SECTION ON LINE A.B.

Inches 12 9 6 3 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 Feet

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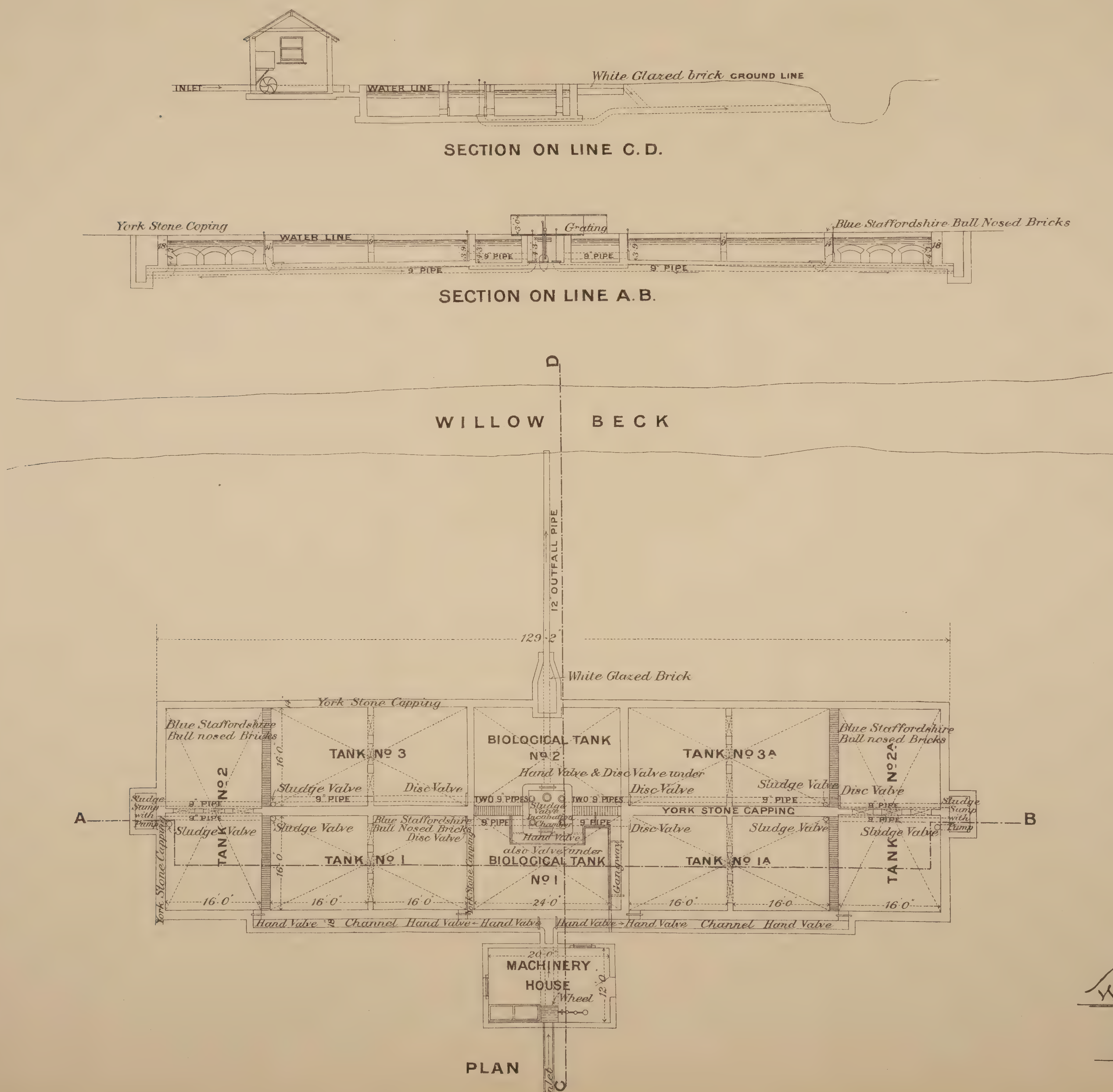
C.

Appendix No. 17. Handed in by W. F. Adeney, Esq.

NORTHALLERTON SEWAGE PURIFICATION WORKS.

THE OXYGEN SEWAGE PURIFICATION COMPANY'S PROCESS 1897.



W. Kaye-Parry. M.A. B.E.
35 Dame St.
Dublin.

Wyman & Sons Ltd, Lith. 63 Carter Lane

APPENDIX, No. 18.

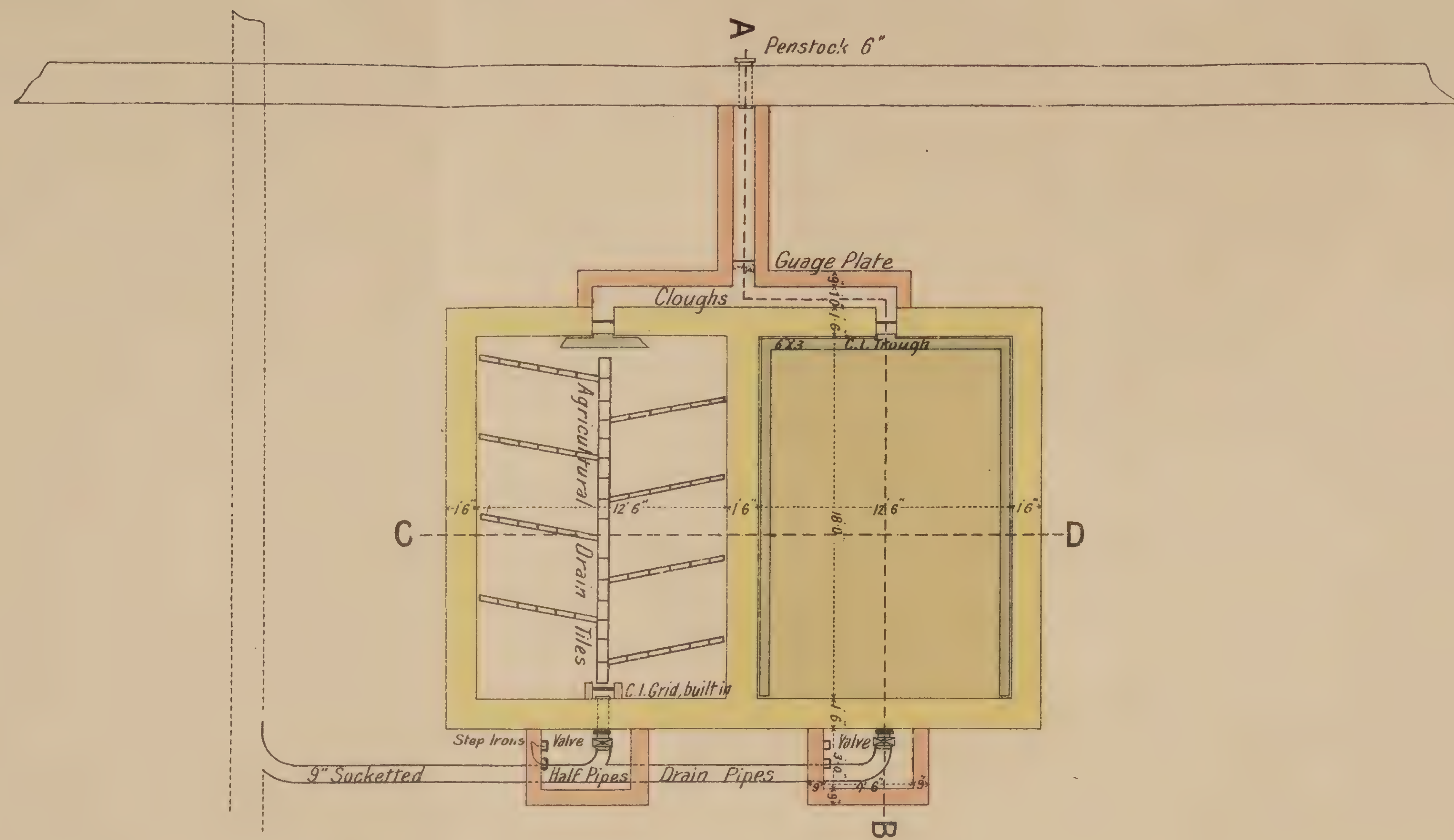
APPENDIX No. 18A.

HANDED IN BY SIR H. ROSCOE F.R.S.

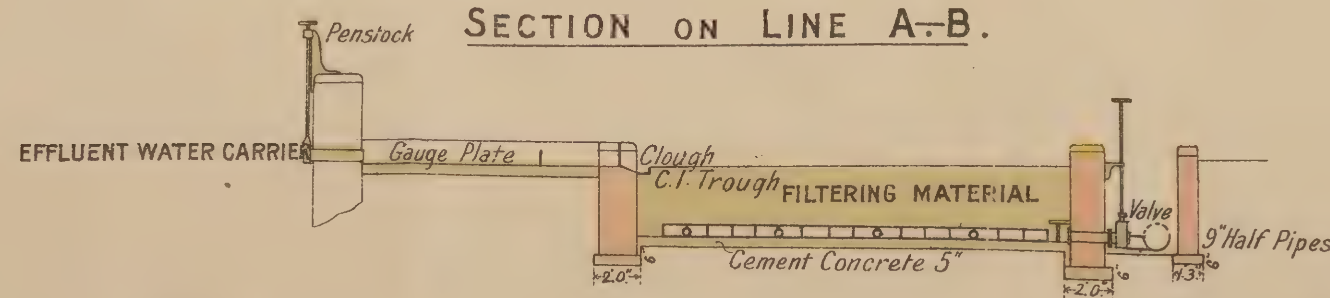
EXPERIMENTAL FILTER BEDS AT DAVYHULME

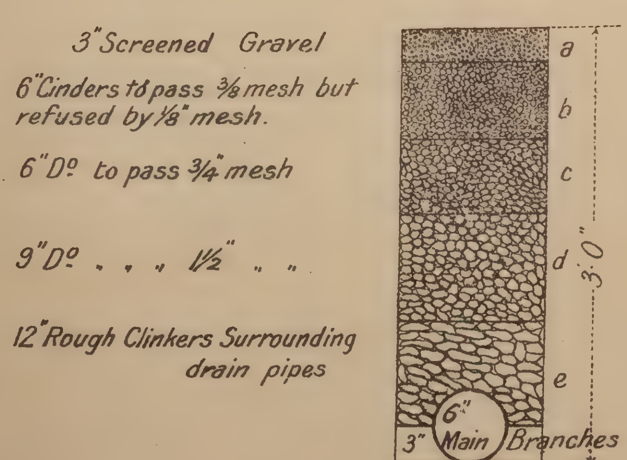
PLAN

EFFLUENT WATER CARRIER

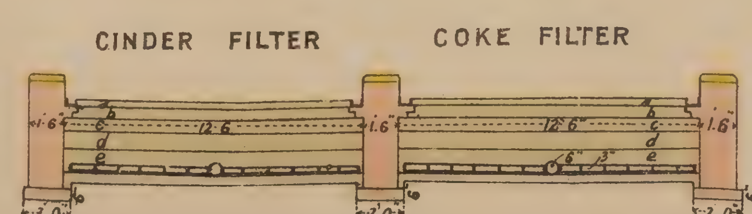


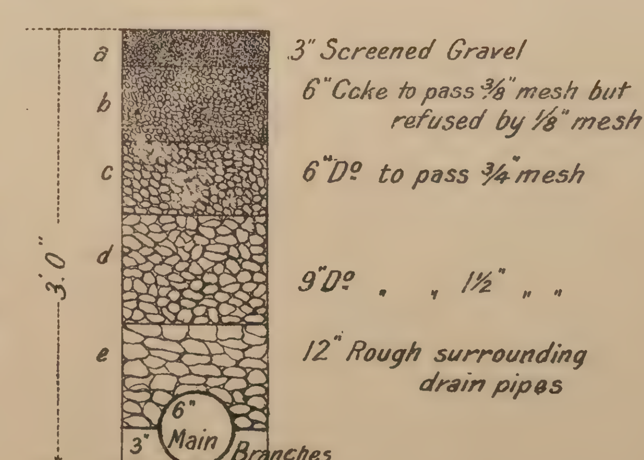
SECTION ON LINE A-B.





SECTION ON LINE C-D.





1055·9·1901.
E. Weller & Graham, Ltd Litho. London.

Appendix No. 18Z

Handed in by Sir Henry Roscoe F.R.S.

MANCHESTER SEWAGE WORKS.

Diagram Z.

Diagram shewing the "putrefactive power of the (1) Tank effluent and the "Oxidation powers" of the (2) Cinder Filtrate and (3) Coke Filtrate.

Results given in Sir Henry Roscoe's report April 1st 1897 to the Manchester Corporation.

Oxygen Absorbed 3 minutes test 1 inch vertical = 0·25 grain of Oxygen per gallon.

Red Column = *Original Sample as analysed.*

Red + Black Columns = { *Sample analysed after 7 days in stoppered bottle kept at a temperature of 75°Fahr.* }

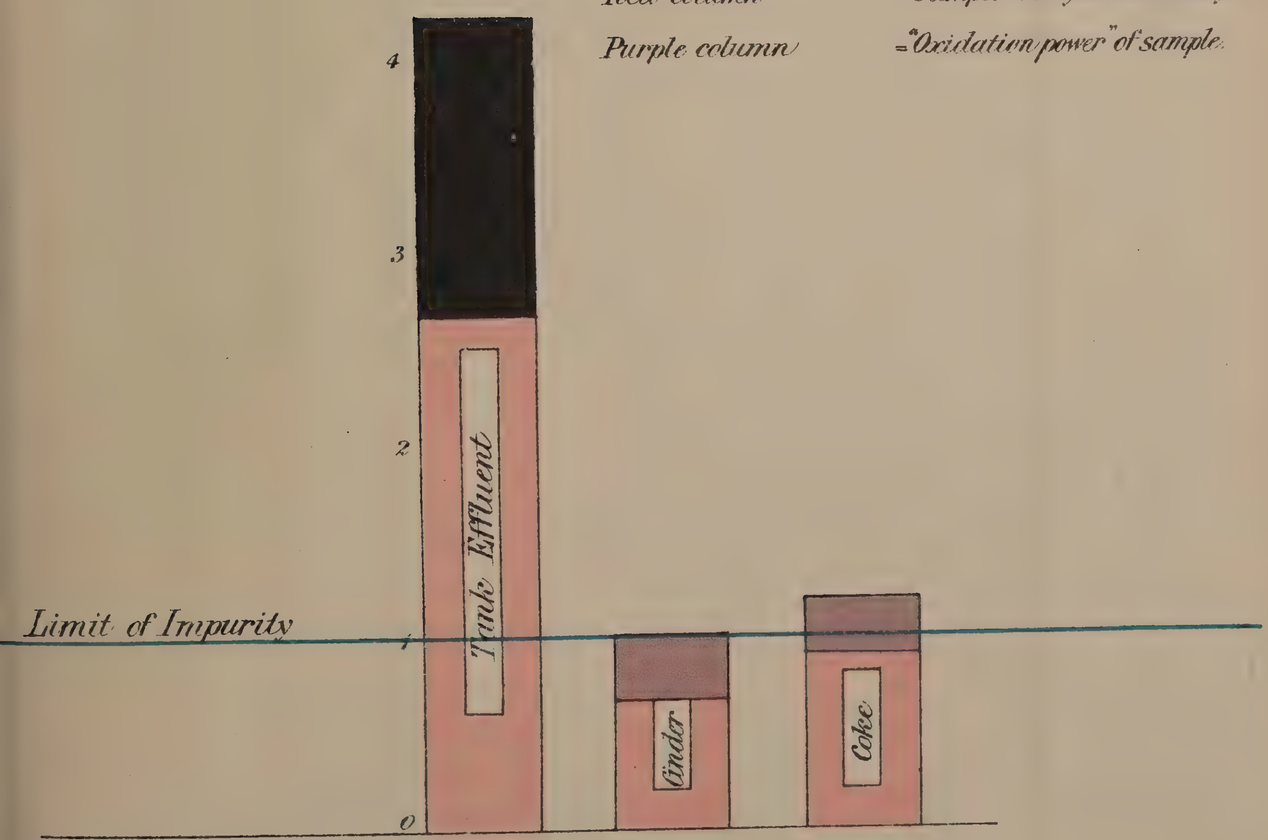
Black Column = *"Putrefactive power" of Sample.*

Cinder & Coke Filtrates do not possess any "Putrefactive power" but a tendency to "oxidise".

Red + purple columns = *Original sample as analysed.*

Red column = *Sample analysed after 7 days.*

Purple column = *"Oxidation power" of sample.*



FRANK SCUDDER, F.I.C., F.C.S.
FOR SIR HENRY ROSCOE.
April 1897.

E. Welter & Grahams, Ltd Litho London.

APPENDIX, No. 19.

APPENDIX No. 19. HANDED IN BY Dr. S. RIDEAL, D.Sc. &c.

Exhibit A.

NITRATE CURVES OF FILTERS (EXETER)

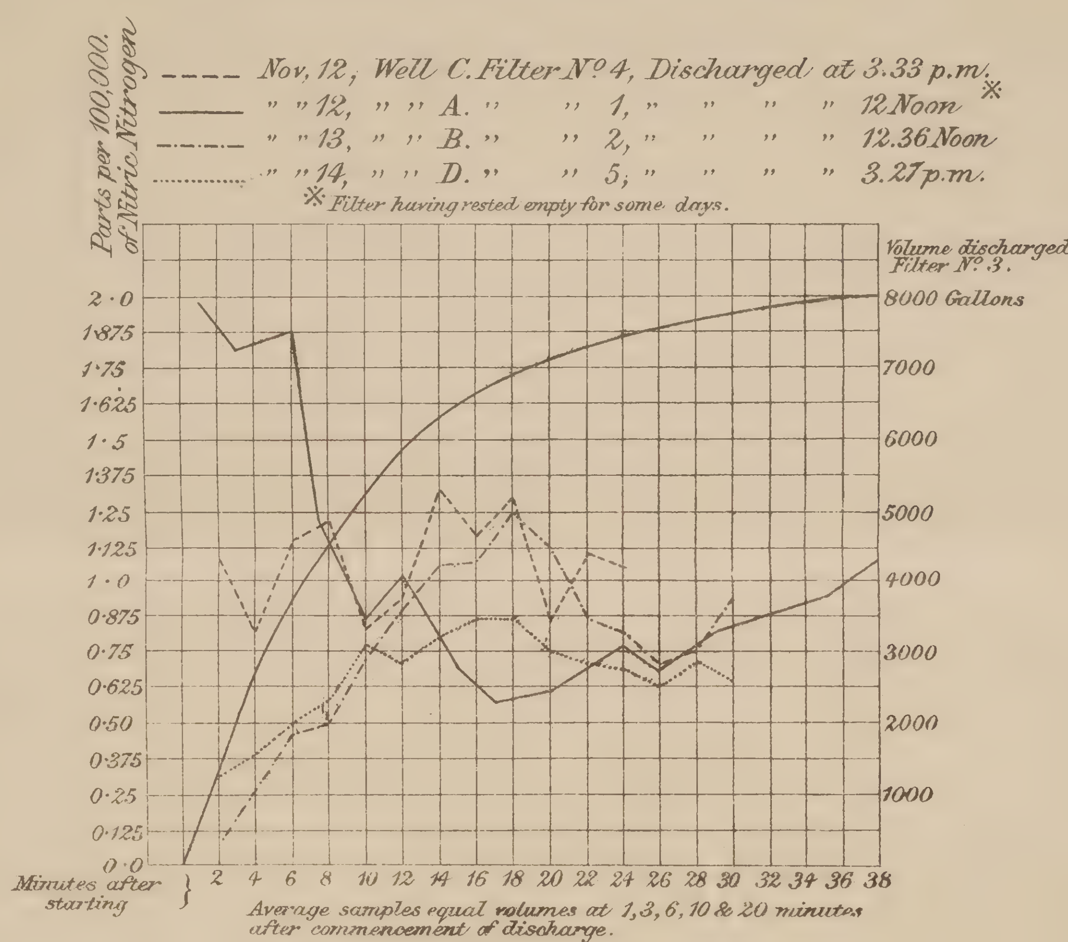


Exhibit B. *First Series Jany. 25th 1898.*

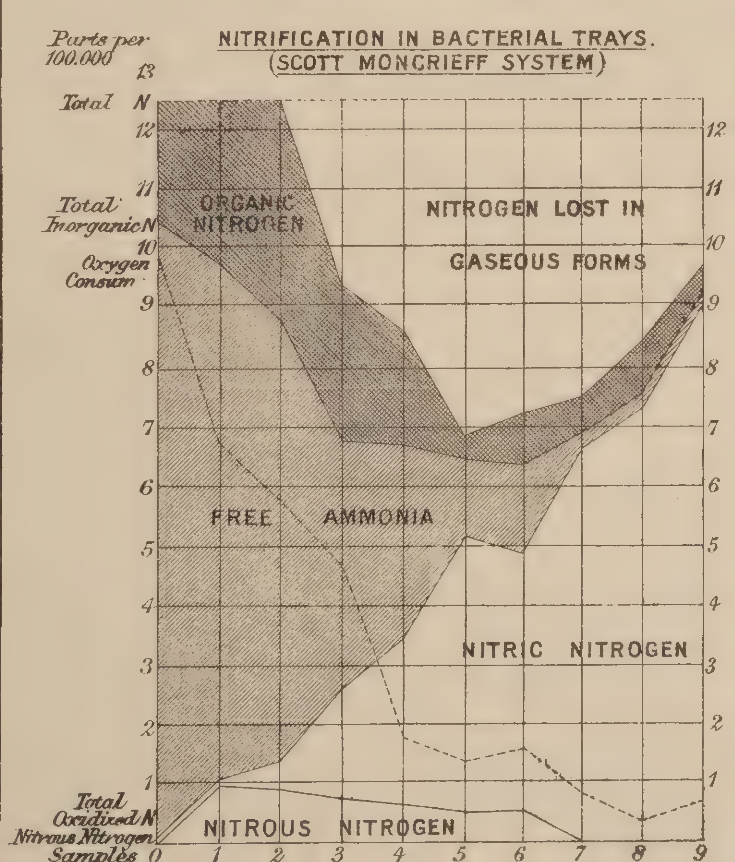
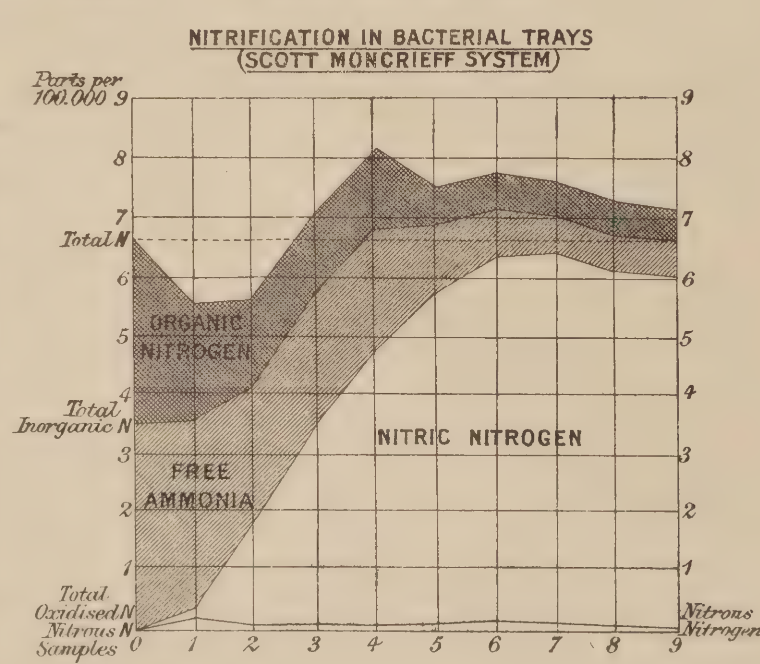


Exhibit C. *Second Series Feby. 8, 1898.*



1065. 9. 1901.

E. Weller & Grahams, Ltd. Litho. London.

APPENDIX, No. 20.

Appendix Nº 20.

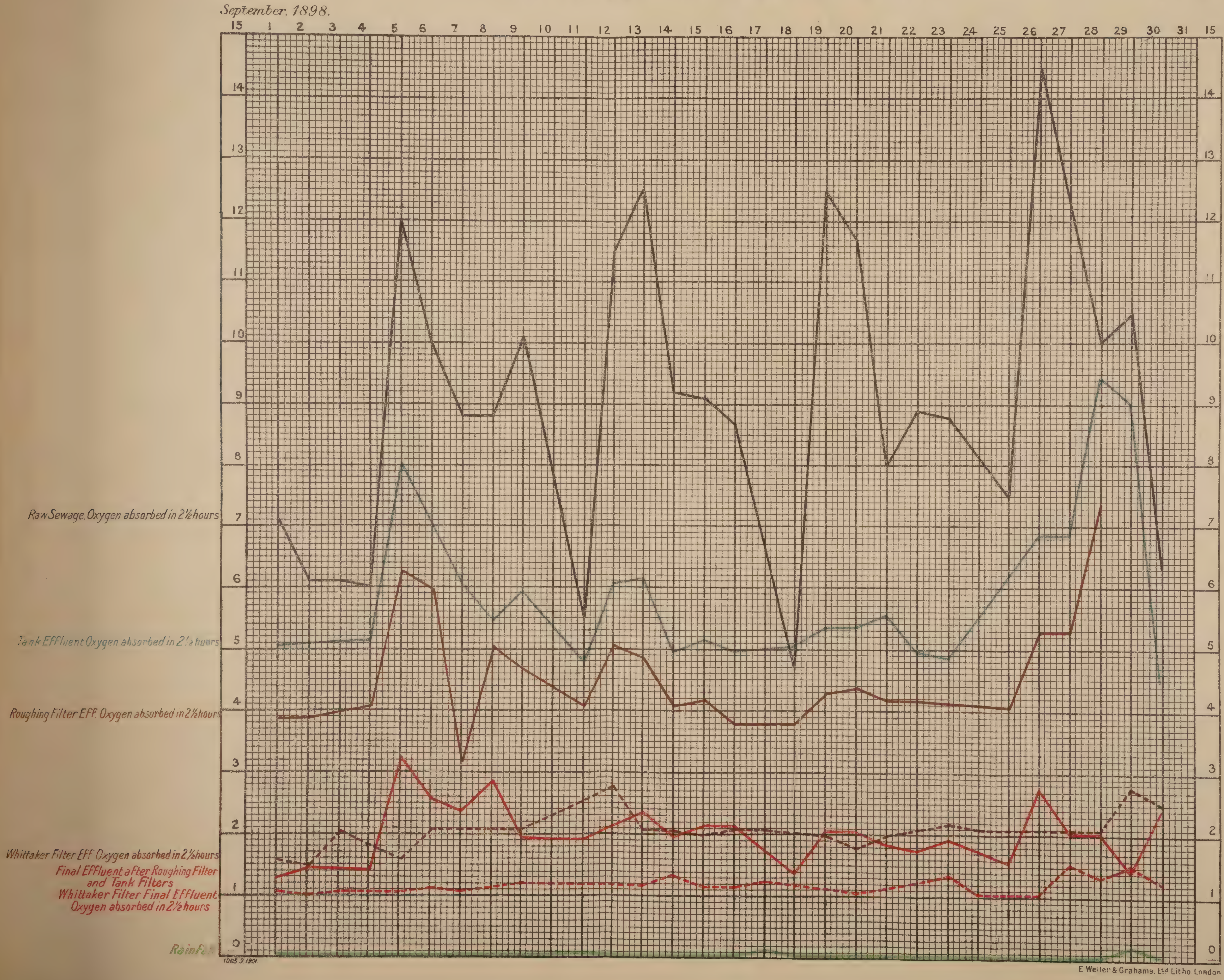
Handed in by C. J. Whittaker Esq.

DIAGRAM showing results of ANALYSIS OF SEWAGE & SEWAGE EFFLUENT.

obtained at

COPPY CLOUGH SEWAGE WORKS.

Diagram Nº 1.



Appendix No. 20.

Handed in by C. J. Whittaker Esq.

DIAGRAM SHOWING RESULTS OF ANALYSIS OF SEWAGE & SEWAGE EFFLUENT.

OBTAINED AT

COPPY CLOUGH SEWAGE WORKS.

Diagram No. 2.

F. Weller & Grahams Ltd. Litho. London

APPENDIX No. 20.

HANDED IN BY C. J. WHITTAKER ESQ.

DIAGRAM SHOWING RESULTS OF ANALYSIS OF SEWAGE & SEWAGE EFFLUENT.

OBTAINED BY

MESSRS. WHITTAKER & BRYANT'S FILTER.

Diagram No. 2, A.

Appendix Nº 20.

Handed in by C. J. Whittaker Esq.

DIAGRAM showing results of ANALYSIS OF SEWAGE & SEWAGE EFFLUENT.

obtained by

MESSRS. WHITTAKER & BRYANT'S FILTER.

Diagram Nº 2,B.

E. Weller & Graham, Ltd Litho London.

Appendix No. 20.

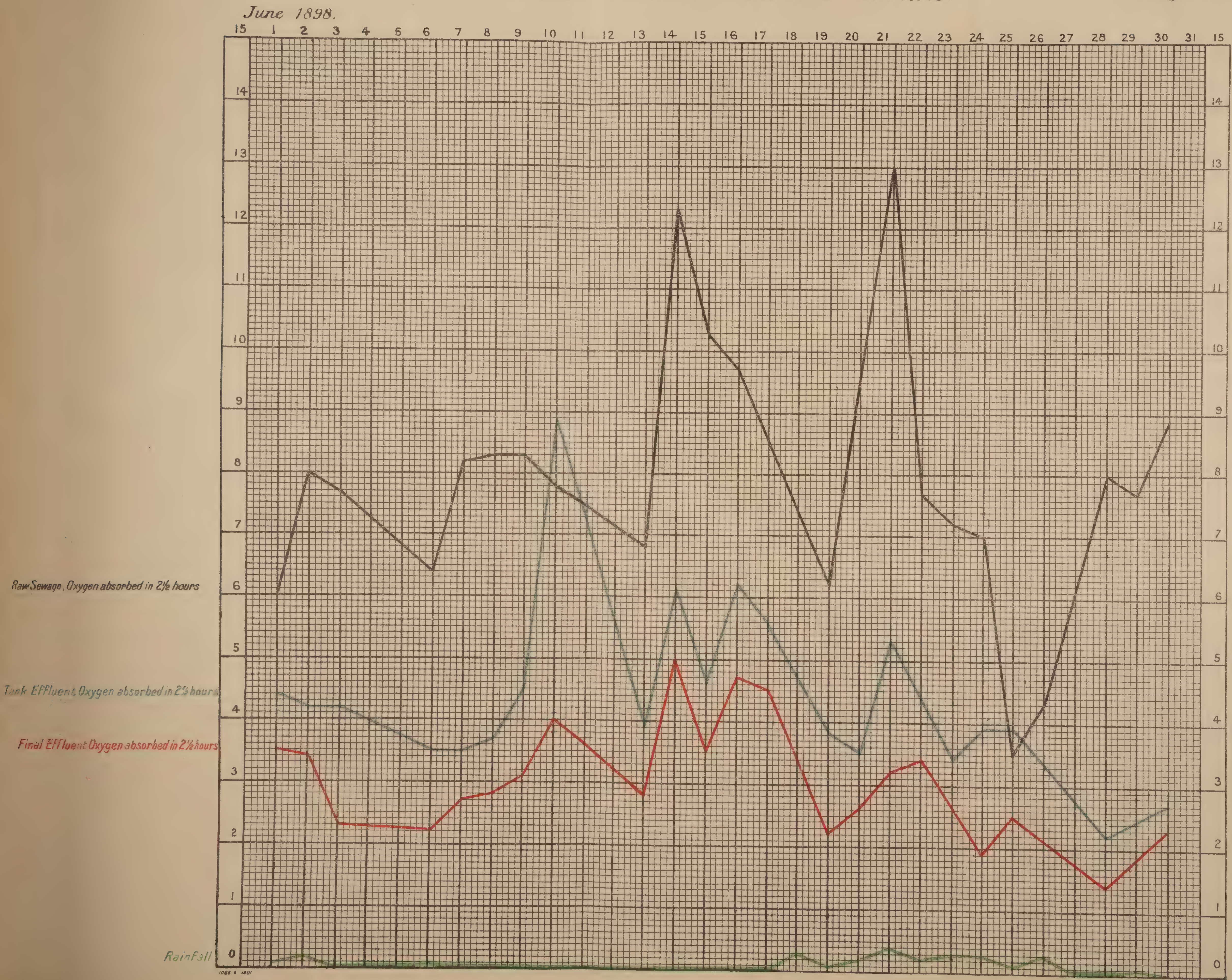
Handed in by C. J. Whittaker Esq.

DIAGRAM SHOWING RESULTS OF ANALYSIS OF SEWAGE & SEWAGE EFFLUENT.

OBTAINED AT

COPPY CLOUGH SEWAGE WORKS.

Diagram No. 3.



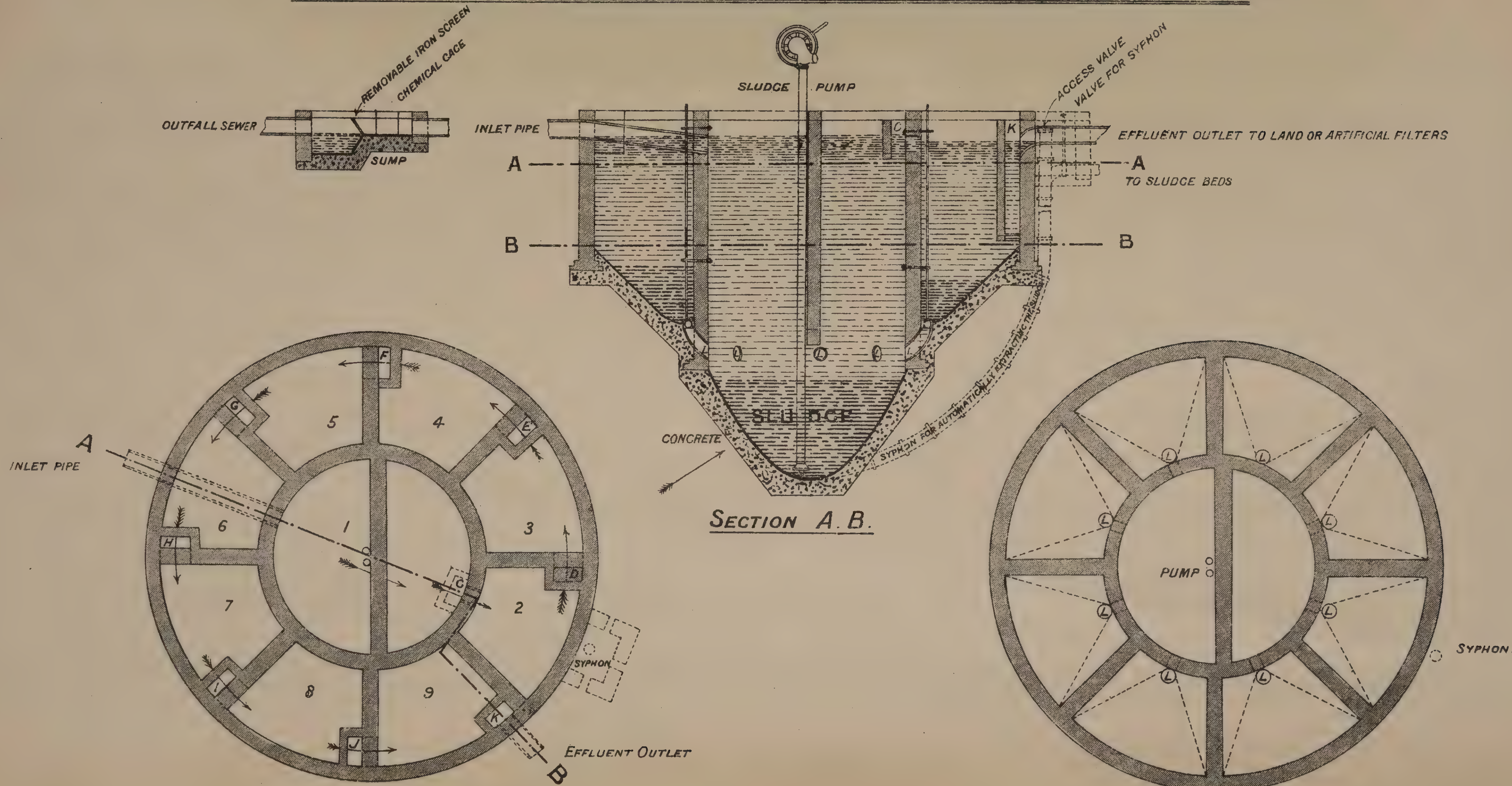
F. Weller & Graham's Ltd Litho London

APPENDIX, No. 21.

THE NATURAL PURIFICATION CO.S – A SYSTEM.

Detail Drawing of

COSHAM'S PATENT CIRCULAR AUTOMATIC PRECIPITATING TANK.



SECTION A.B.

SECTIONAL PLAN AT A.A.

SECTIONAL PLAN AT B.B.

APPENDIX, No. 22.

APPENDIX Nº 22.

HANDED IN BY DR A. C. HOUSTON AND DR G. MC GOWAN.

CURVES SHOWING THE RELATIONSHIP IN SEWAGES AND EFFLUENTS BETWEEN (1) THE NUMBERS OF B. ENTERITIDIS SPOROGENES AND OF B. COLI; (2) HOUSTON'S BACTERIAL GAS TEST; (3) THE GENERAL CHEMICAL ANALYSIS (APPROXIMATE CURVE); AND (4) SCUDDER'S CHEMICAL INCUBATION TEST AS JUDGED BY SMELL.

NOTE.

(1) The Provisional Standards apply only to Streams not used for Drinking purposes.

(2) Dr Houston has put his Provisional Bacteriological Standard mid-way between a "Fairly Satisfactory" & a "Good Effluent". I should feel inclined at present to pass those Effluents (Excepting Nº 43) which come within the Chemical line "Fairly Satisfactory". This, however, is not a high standard.

Decr. 4th 1900.

Geo. McGowan

ROYAL COMMISSION ON SEWAGE DISPOSAL.

SECOND REPORT

OF

THE COMMISSIONERS

APPOINTED IN 1898

TO INQUIRE AND REPORT WHAT METHODS OF

TREATING AND DISPOSING OF SEWAGE

(Including any Liquid from any Factory or Manufacturing Process)

MAY PROPERLY BE ADOPTED.

Presented to both Houses of Parliament by Command of His Majesty.

LONDON:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE,
BY WYMAN AND SONS, LIMITED, FETTER LANE, E.C.

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EYRE and SPOTTISWOODE, East Harding Street, Fleet Street, E.C., and
32, Abingdon Street, Westminster, S.W.; or
OLIVER and BOYD, Edinburgh; or
E. PONSONBY, 116, Grafton Street, Dublin.

1902.

[Cd. 1178.] *Price 4s. 10d.*

VICTORIA R.

Victoria, by the Grace of God, of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith: To Our Right Trusty and Right Well-beloved Cousin, Walter Stafford, Earl of Iddesleigh, Companion of Our Most Honourable Order of the Bath; Our Trusty and Well-beloved Sir Richard Thorne Thorne, Knight Commander of Our Most Honourable Order of the Bath, Medical Officer of the Local Government Board; Our Trusty and Well-beloved Constantine Phipps Carey, Esquire, Lieutenant-Colonel and Honorary Major-General on the Retired List of Our Army; Our Trusty and Well-beloved Charles Philip Cotton, Esquire; Our Trusty and Well-beloved Michael Foster, Esquire, Master of Arts, Professor of Physiology in Our University of Cambridge; Our Trusty and Well-beloved Thomas Walter Harding, Esquire, Retired Lieutenant-Colonel of Our Auxiliary Forces, with Honorary Rank of Colonel; Our Trusty and Well-beloved Thomas William Killick, Esquire; Our Trusty and Well-beloved William Ramsay, Esquire, Professor of Chemistry, University College, London; and Our Trusty and Well-beloved James Burn Russell, Esquire, Doctor of Medicine, Master of Surgery: Greeting!

Whereas We have deemed it expedient that a Commission should forthwith issue to inquire and report:

1. (1) What method or methods of treating and disposing of sewage (including any liquid from any factory, or manufacturing process) may properly be adopted, consistently with due regard for the requirements of the existing law, for the protection of the public health, and for the economical and efficient discharge of the duties of local authorities; and

   (2) If more than one method may be so adopted, by what rules, in relation to the nature or volume of sewage, or the population to be served, or other varying circumstances or requirements, should the particular method of treatment and disposal to be adopted be determined; and

2. To make any recommendations which may be deemed desirable with reference to the treatment and disposal of sewage;

Now know ye, that We, reposing great trust and confidence in your knowledge and ability, have authorised and appointed, and do by these Presents authorise and appoint, you, the said Walter Stafford, Earl of Iddesleigh, Sir Richard Thorne Thorne, Constantine Phipps Carey, Charles Philip Cotton, Michael Foster, Thomas Walter Harding, Thomas William Killick, William Ramsay, and James Burn Russell to be Our Commissioners for the purposes of the said Inquiry.

And, for the better effecting the purposes of this, Our Commission, We do by these Presents give and grant unto you, or any three or more of you

full power to call before you such persons as you shall judge likely to afford you any information upon the subject of this Our Commission; and also to call for, have access to, and examine, all such books, documents, registers, and records as may afford you the fullest information on the subject, and to inquire of and concerning the premises by all other lawful ways and means whatsoever.

And We do by these Presents authorise and empower you, or any three or more of you, to visit and personally inspect such places as you may deem it expedient so to inspect for the more effectual carrying out of the purposes aforesaid.

And We do further by these Presents will and ordain that this Our Commission shall continue in full force and virtue, and that you, Our said Commissioners, or any three or more of you, may from time to time proceed in the execution thereof, and of every matter and thing therein contained, although the same be not continued from time to time by adjournment.

And We do further ordain that you, or any three or more of you, have liberty to report your proceedings under this Our Commission from time to time, if you shall judge it expedient so to do.

And Our further Will and Pleasure is that you do, with as little delay as possible, report to Us under your hands and seals, or under the hands and seals of any three or more of you, your opinion upon the matters herein submitted for your consideration.

And for the purpose of aiding you in such matters, We hereby appoint Our Trusty and Well-beloved Frederick James Willis, Esquire, to be Secretary to this Our Commission.

Given at Our Court at Saint James's, the Seventh day of May, One thousand eight hundred and ninety-eight, in the Sixty-first Year of Our Reign.

By Her Majesty's Command,

(Signed) M. W. Ridley.

William Henry Power, Esq., F.R.S.,
To be a Member of the Royal Commission on Sewage Disposal.

VICTORIA, R.

Victoria, by the Grace of God, of the United Kingdom of Great Britain and Ireland, Queen, Defender of the Faith: To Our Right Trusty and Well-beloved William Henry Power, Esquire, Fellow of the Royal Society, Medical Officer of the Local Government Board: Greeting!

Whereas We did, by Warrant under Our Royal Sign Manual, bearing date the Seventh day of May, One thousand eight hundred and ninety-eight, appoint Our Right Trusty and Right Well-beloved cousin Walter Stafford, Earl of Iddesleigh, Companion of Our Most Honourable Order of the Bath, together with the several Gentlemen therein mentioned, or any three or more of them, to inquire into the treatment and disposal of sewage.

And Whereas One of the Commissioners so appointed, namely, Sir Richard Thorne Thorne, has since deceased.

Now know Ye, that We, reposing great confidence in you, do, by these presents, appoint you, the said William Henry Power, to be one of Our Commissioners for the purpose aforesaid, in the room of the said Sir Richard Thorne Thorne, deceased, in addition to, and together with, the other Commissioners whom we have already appointed.

Given at our Court, at Saint James's, the Seventh day of February, One thousand nine hundred, in the Sixty-third Year of Our Reign.

By Her Majesty's Command,

(Signed) M. W. Ridley.

Whitehall, March 18th, 1901.

The King has been pleased to issue a Commission, under His Majesty's Royal Sign Manual, to the following effect:—

EDWARD, R.

Edward the Seventh, by the Grace of God, of the United Kingdom of Great Britain and Ireland King, Defender of the Faith, to all to whom these Presents shall come, Greeting!

Whereas it pleased Her late Majesty from time to time to issue Royal Commissions of Inquiry for various purposes therein specified:

And Whereas in the case of certain of these Commissions, namely, those known as—

The Historical Manuscripts Commission;
The Horse Breeding Commission;
The Local Taxation Commission;
The Port of London Commission;
The Salmon Fisheries Commission; and
The Sewage Disposal Commission;

the Commissioners appointed by Her late Majesty, or such of them as were then acting as Commissioners, were, at the late demise of the Crown. still engaged upon the business entrusted to them :

And whereas We deem it expedient that the said Commissioners should continue their labours in connection with the said inquiries notwithstanding the late demise of the Crown :

Now Know Ye, that We, reposing great trust and confidence in the zeal, discretion, and ability of the present members of each of the said Commissions, do by these Presents authorize them to continue their labours, and do hereby in every essential particular ratify and confirm the terms of the said several Commissions.

And We do further ordain that the said Commissioners do report to Us under their hands and seals, or under the hands and seals of such of their number as may be specified in the said Commissions respectively, their opinion upon the matters presented for their consideration ; and that any proceedings which they or any of them may have taken under and in pursuance of the said Commissions since the late demise of the Crown, and before the issue of these Presents shall be deemed and adjudged to have been taken under and in virtue of this Our Commission.

Given at Our Court at Saint James's, the fourth day of March, One thousand nine hundred and one, in the First Year of Our Reign.

By His Majesty's Command,

(Signed) CHAS. T. RITCHIE.

SECOND REPORT.

TO THE KING'S MOST EXCELLENT MAJESTY.

MAY IT PLEASE YOUR MAJESTY,

We, the undersigned Commissioners appointed to inquire into the subject of the Treatment and Disposal of Sewage (including any liquid from any factory or manufacturing process), desire humbly to submit to Your Majesty the following Reports which have been made by the officers appointed by us for the purpose of our investigations :—

(1) The Oxidation of Sterile Sewage. By *Mr. Colin C. Frye.*

(2) The Manchester Experiments.
By *Professor Boyce* and *Dr. G. McGowan.*

(3) Bacteriological Standards in relation to potable and non-potable streams. By *Dr. A. C. Houston.*

(4) Anthrax in Yeovil Sewage. By *Dr. A. C. Houston.*

(5) The Subcutaneous Injection of Animals. By *Dr. A. C. Houston*

(6) The Longevity of B. Typhosus in Sewage.
By *Dr. A. MacConkey.*

(7) Effect of Filtration in reducing the number of Bacteria in Sewage Effluents.
By *Professor Boyce* and *Drs. MacConkey, Grünbaum,* and *Hill.*

(8) The Pollution of the River Severn in the Shrewsbury District.
By *Professor Boyce* and *Drs. MacConkey. Grünbaum* and *Hill*

(9) The Self-purification of the River Severn. By *Mr. Colin C. Frye.*

(10) Some of the chief methods used in the Bacteriological Examination of Sewage and Effluents. By *Dr. A. C. Houston.*

We regret to have to state that since the issue of our previous Report, Mr. Thomas William Killick and Mr. Charles Philip Cotton have found it necessary to resign their seats on the Commission.

(Signed) IDDESLEIGH (*Chairman*),
C. PHIPPS CAREY,
M. FOSTER,
T. WALTER HARDING,
WILLIAM RAMSAY,
JAS. B. RUSSELL,
W. H. POWER.

F. J. WILLIS, Secretary,
7th July, 1902.

CONTENTS.

THE OXIDATION OF STERILE SEWAGE.

It has long been known that sterile sewage undergoes no change when kept, and it was with the object of ascertaining whether or not this held when sewage is exposed in thin films to the air that these experiments were made.

The experiments were made in three series, which may be given under the following heading:—

I. Filtration of sewage sterilised by the addition of mercuric chloride.

II. Filtration of sterile sewage through a sterile filter, the sterilisation in this case being obtained by repeated exposure to steam at 100 deg. C.

III. Filtration of sterile sewage through a non-sterile filter.

The object in each particular series being:—

I. To show the absence of oxidation in sterile sewage as it passes through the filter.

II. To show the results of No. 1 was not due to the mercuric chloride *per se*.

III. To show that the results obtained from No. 2 were not due to the use of heat, but to the absence of bacteria.

I.

For this experiment well-settled sewage containing ·05 per cent of mercuric chloride was allowed to trickle continuously through an open filter 4 ft. long and 9 in. diameter), composed of rough coke, the effluent being collected from time to time.

For purposes of comparison sewage containing no mercuric chloride was allowed to pass at the same rate through an exactly similar filter.

The coke in both cases was taken direct from the No. 2 Whitaker Bed, at Leeds, and was therefore fully matured at the start.

The filters worked for one month, during which time the average percentage purification (three analyses) of the sewage passing into each filter was as follows:—

——	Filter A. Receiving Sewage containing Mercury.	Filter B. Receiving Normal Sewage.
Percentage Purification.	14	47

The more important result, however, was the production of nitrate and nitrite nitrogen, and this in the case of each analysis was:—

—	Filter A.		Filter B.	
	Nitrite Nitrogen.	Nitrate Nitrogen.	Nitrite Nitrogen.	Nitrate Nitrogen.
(1)	Trace - -	None - -	·114	·360
(2)	None - -	·080	None - -	·320
(3)	None - -	·030	None - -	·354

and to take this as a test of oxidation is to say that the oxidation which took place in the sewage containing the mercuric chloride was exceedingly small.

II.

Filtration of sterile sewage through a sterile filter, the sterilisation being obtained in this case by means of steam at 100 deg. C.

For this experiment steam sterilised settled sewage was run through a small filter (2 ft. long and 2 in. diameter), which was enclosed in a glass tube, and the results again compared with those given by a similar filter which was treating normal settled sewage.

The life of these filters was two months, and the figures of five analyses made during this time show the following average percentage purification:—

——	Sterile Filter A. Sewage.	Filter B. Sewage.
Percentage purification -	17	42

The production of nitrate and nitrite nitrogen in parts per 100,000 for this series was:

—	Sterile Filter A.		Filter B.	
	Nitrite Nitrogen.	Nitrate Nitrogen.	Nitrite Nitrogen.	Nitrate Nitrogen.
(1)	None - -	·050	·020	·140
(2)	None - -	None - -	None - -	·123
(3)	None - -	None - -	·051	·535
(4)	Trace - -	None - -	Trace - -	434
(5)	None - -	·030	None - -	·640

and therefore the results both in average percentage purification and in the production of nitrates show a remarkable agreement with those obtained from experiment No. I.

III.

Filtration of steam sterilised sewage through a non-sterile filter.

This was practically a repetition of experiment No. II., except that sewage sterilised by means of steam at 100 deg. C. was allowed to run on to both the sterile and non-sterile filters.

The percentage purification given by the two filters under these conditions, for one analysis, was:—

——	Sterile Filter A. receiving Sterile Sewage.	Normal Filter B. receiving Sterile Sewage.
Percentage Purification.	15	38

and the production of nitrate and nitrite nitrogen:—

Sterile Filter A.		Filter B.	
Nitrite Nitrogen.	Nitrate Nitrogen.	Nitrite Nitrogen.	Nitrate Nitrogen.
None - - -	·030	None - -	·640

So the result from this experiment is, therefore, in agreement with those obtained from the former ones.

Conclusion.

The average percentage purification for all the experiments works out as follows:—

——	Sterile Filters.	Normal Filters.
Percentage Purification	15	42

Or, in other words, the sterile filters did about one-third of the work done by the normal filters.

The average production of nitrate and nitrite nitrogen for all the experiments has been:—

Sterile Filters.		Normal Filters.	
Nitrite Nitrogen.	Nitrate Nitrogen.	Nitrite Nitrogen.	Nitrate Nitrogen.
Trace.	·027	·017	·452

and the oxidation of the sterile sewage as measured by these was therefore one-seventeenth of the oxidation which took place in the normal sewage.

I conclude, therefore, that the oxidation of sewage containing no bacteria is very slow, or, in other words, that the chemical oxidation due to the oxygen in the atmosphere is unappreciable.

The bacteriological analyses for this work have been made by Dr. MacConkey at Liverpool.

(Signed) Colin C. Frye.

Leeds, May 10th, 1900.

REPORT OF PROFESSOR BOYCE UPON THE TREATMENT OF THE MANCHESTER SEWAGE BY MEANS OF BACTERIAL BEDS.

The Finding of the Experts.

On October 30th, 1899 an Experts' Report on the treatment of the Manchester Sewage was published. The report was in favour of adopting a bacterial method of treatment. The experts arrived at this conclusion partly as the result of experiments made by Sir Henry Roscoe and subsequently by Mr. Fowler, and also as the result of a year's observation of experimental beds which they themselves had constructed. The experts being favourably impressed with the bacterial method of treatment, especially directed their attention to

1. "Whether the trade refuse in Manchester sewage seriously impaired the efficiency of the bacteriological treatment.

2. "Whether a portion at any rate of the sludge can be destroyed by bacterial agency.

3. "Whether the addition of chemicals to the sewage before bacteriological treatment can be dispensed with.

4. "Whether the aërobic process (decomposition of organic matter by bacteria in the presence of air) or a combination of anaërobic (similar decomposition without air) and aërobic processes is the more advantageous."

The experts early noted the diminution in the capacity of the beds and concluded that :

1. "The suspended matter must be removed as far as possible by sedimentation.
2. "Any suspended matter not so removed should be retained as far as possible on the surface of the bed.
3. "For maintaining the efficiency of such beds, the surface must be raked or forked over from time to time.
4. "Periodical intervals of rest must be allowed."

Thus they state that septic tanks should be used for :

(*a*) "Protecting the contact beds from receiving not only the mineral detritus of the crude sewage, but also as much as possible of the suspended organic matters contained in the latter.

(*b*) "That as much as possible of the suspended organic matter deposited during the passage of the crude sewage through these tanks should be destroyed by the well-known anaërobic bacterial processes taking place in cesspools and the like

(*c*) "That the sewage actually passing on to the bacterial beds should by means of these tanks be not only free from suspended matter, but also rendered of more uniform character, and thus prevent the excessive demands otherwise made at times upon the bacterial activity of the beds.

(*d*) "That after having undergone the anaërobic processes in the tanks, the liquid would be in a condition to more readily undergo nitrification."

With regard to the treatment of the increased flow during rain (storm water) they state that :

"It is evident that a distinction must be drawn between the first flush of a storm and the highly-diluted sewage which follows, the latter alone being properly designated as storm water. The detailed analysis in connection with the above experiments indicated that the "first flush" lasts, in the case of Manchester, from two to four hours, according to circumstances."

They conclude therefore that :

1. "Provision must be made for the storage of the 'first flush' of sewage at the beginning of a storm.
2. "It is probable that accelerated treatment may be commenced about two hours after the augmented flow has begun to reach the works.
3. "Adequate purification of storm water can be effected by short double contacts, or in the case of extreme dilution even by single contact, the length of the cycle being inversely proportional to the flow of sewage.
4. "When, after a storm, ordinary treatment is resumed, the beds have been proved by experiment to show no decrease in purifying efficiency."

They finally conclude :

That the bacterial system is that method best adapted for the Manchester sewage.

That double contact is best.

That the sewage should be first passed through a septic tank.

That the open septic tank is as efficacious as the closed, that:

"In order that a bacterial contact bed may exercise its full powers of purification, it is necessary—

(*a*) That it should be allowed sufficiently frequent and prolonged periods of rest.

That the sewage applied to it should, as far as possible, be free from suspended matters;

(*c*) That the sewage applied to it should be of as uniform a character as possible.

That the capacity of bacterial contact beds has been found to remain practically constant after they have been in operation for a period of three months.

That in the event of a bed having been unduly taxed, its efficacy is only temporarily impaired and can be restored by a few days' repose.

That the bacterial system of treatment is efficacious at all seasons of the year.

Analysis of the Experts' Report.

The report of the experts is largely based upon observations of their own, extending over a period of one year. This is in my opinion too short a period in which to come to a definite conclusion, especially as regards the life of a bed.

They make no mention of the bacterial condition of the effluents, and have tested the purity of the effluents by chemical means only.

The following is a brief analysis of the chief points in the finding of the experts, together with my own experiments and observations.

1. "*Does the trade refuse in Manchester sewage seriously impair the efficacy of the bacterial treatment?*"

I agree with the experts that it does not. The most striking feature of the Manchester sewage is its tar-like odour. To the presence of tar compounds I attribute the comparatively small number of B. coli in the sewage, and septic tank liquors as compared with Leeds or Liverpool. A domestic sewage is far richer in B coli. Whilst the nature of the Manchester sewage will tend to eliminate pathogenic forms, a fact which is shown by the increased diminution of the B coli during the stay in the septic tanks, and by experiments in the laboratory, the efficacy of the beds is not interfered with; this is shown both by the chemical analyses of the experts and my own bacteriological results, which demonstrate a further diminution in the number of the B. coli. As additional proof that bacterial activity is not checked in the beds, I have found that the effluent from the rough bed (first contact bed) is prone to undergo putrefaction; its odour contrasting markedly with that of the septic tank liquor which flows on to it.

2. "*Is a portion at any rate of the sludge destroyed by bacterial agency?*"

Numerous experiments show that a portion of the sludge is destroyed; this was demonstrated in my early oxidation experiments. But to determine the amount of sludge destroyed on a practical scale, prolonged observation is necessary, and the period of one year of observation by the experts appears to me to be too short.

In the Experts' Report (October 30th, 1899) they state that after some nine months, during which the open septic tank had been in use, the "only notable quantity of sludge which can be perceived, on dipping with a rod, is immediately beneath the inlet penstocks." But six months afterwards (last April), when I took measurement of the same tank, one half of its capacity had been reduced by sludge, whilst the small settling tank which fed it was full. At the same time a very large amount of sludge in suspension, as shown by centrifugalisation, was passing over the lip of the tank. The destruction of sludge is not a rapid process. We determined this in the case of observations upon the Leeds sewage, and by experiments on sludge in the laboratory. The sludge of a manufacturing town is more resistant than that of a domestic sewage which contains more readily putrefactive elements. There is also a very considerable inorganic residue, as the following experiment shows.

Twelve grammes of sludge obtained from the open septic tank (Manchester, April 3rd, 1900) were carefully dried.

The dried sludge weighed 1·442 grammes. After careful incineration the residue weighed ·814 grammes.

This experiment shows that more than one-half of the dried sludge consists of inorganic material. Depending therefore upon the source of the crude sewage, I conclude that the septic tank will gradually sludge up and the more the tank tends to sludge the more sludge in suspension is carried over into the contact beds, owing to the disturbance of the gradually rising floor of sludge. It is worthy of note that the dried sludge of Manchester burns readily when heated.

As in the case of the open septic tank, the closed septic tank shows an increasing deposit and the presence of much suspended sludge in the effluent. The following figures show the amount of sludge precipitable by centrifugalisation in 600 cc. of the effluent from, 1, the open septic tank, 2, the Cameron tank, and 3, a tank in which chemical precipitation is used.

Open septic tank contains	-	·7 cc. in 600 cc.
Cameron tank ,,	-	·5 cc. ,, ,,
Precipitating tank ,,	-	·1 cc. ,, ,,

(The precipitating tank is cleansed at frequent intervals, whilst the other two have not been disturbed since they were started.)

The chemical analyses of the effluents of the contact beds show that a very great degree of purification takes place and that therefore destruction of organic matter is going on. This is at the expense of a gradual reduction in capacity of the bed. The experts are of opinion that the early decrease in capacity is due to the material of the bed becoming clothed with spongy bacterial growths. If this is so, one would expect the growth to increase, but they state that after a comparatively short space of time the beds acquire a practically constant capacity. On the other hand the figures given by Mr. Fowler of the capacities of the beds from March, 1899, to March 1900, show a gradual diminution of capacity. This is in accord with our own observations at Leeds and Liverpool, extending over a period of one year. The experts state that the increase of the capacity in the beds after long periods of rest is due to the removal of oxidisable organic matter entangled in the body of the beds. I agree that the destruction of solid organic matter takes place most advantageously during the period of rest in the moist bed. This is well demonstrated in the comparatively rapid destruction of solid organic materials when worked into ploughed land, and in the method of freeing bone from attached structures, by covering with damp sand, &c. But as in the case of the sludge of the septic tank, so in the case of the contact bed, there is an increasing accumulation of inorganic material. It has occurred in connection with the land of the sewage farm, and leads there to the gradual diminution of porosity. That, in the case of the Manchester experimental beds, a large quantity of suspended material, partly organic and partly inorganic, is continually poured on to them will be seen from the figures already given of the amount of suspended matter in the septic tank effluent and of the amount of inorganic residue in the dried sludge of the tank.

But the experts recognised the danger of permanent loss of capacity, for they early introduced in their experiments the septic tank as a preliminary treatment in order that the "*sewage passing in the beds should be free from suspended matter.*" They early relegated the destruction of the solid organic material to the septic tank. The working, therefore, of the septic tank must be as carefully watched and regulated as the contact bed, or otherwise a large amount of suspended sludge passes over. The experts also state that "any suspended matter not so removed (septic tank treatment) should be retained as far as possible on the surface of the bed." I agree with this, and instance the case of water filtration through sand, where a felt-work accummulates on the surface, and then is skimmed off, but even here clogging of the deeper layers of sand occurs, and necessitates periodical washing. I may also mention that in the case of the Liverpool experiments at West Derby, where the crude sewage has been run directly on to coarse beds, the accumulations of sludge throughout the beds has been very great (these beds are now under observation), but in the finer beds a layer has formed on the top, which has protected the rest of the bed. Mr. Fowler informs me that diminished capacity corresponds, within limits, to increased chemical efficiency. This is in accord with the early observations upon the mode of action of contact beds which I brought to the notice of the Commission. I pointed out that the beds had a filtering action, and that this action was increased by the use of fine material.

Can the addition of chemicals to the sewage before bacterial treatment be dispensed with?"

The experts' report is against the use of chemical precipitation. But it was first thought that the beds would get rid of the sludge difficulty. We have seen, however, the experts soon recognised that some process must take the place of the precipitating tank, and so the septic tank was used. At Chorley we demonstrated by a long series of experiments how efficacious thorough chemical precipitation, followed by filtration, might be; and we brought to the notice of the Commission similar processes in use in Germany. It is a question of expense. If the septic process is used it will be noted from what has been stated above that sludge will still accumulate, and will require to be removed. It is of interest to note that in my observations at Manchester I have found the sludge of the precipitating tank much more prone to putrefactive decomposition than that of the septic tank. We have before pointed out the objections to lime sludge. The precipitated sludge burns on ignition with a luminous flame.

Disadvantage of lime-precipitated sludge.

4. "*Is the aerobic process or a combination of the anaerobic and aerobic processes the most advantageous?*"

As pointed out in the preceding pages, the experts concluded that the combination was the best. From my own observations I agree with this, provided that the septic process is made more perfect than at present and suspended sludge be prevented from passing over on to the beds. Our experiments at Leeds and Manchester show that the B coli diminishes during the stay in the septic tank, and experiments conducted in the laboratory show that the septic tank liquor is inimical to the B. coli and therefore to the other more delicate pathogenic bacteria.

The septic tank process to be perfected.

Thus in one series of observations at Manchester, average number of B. coli per cc. was—

Septic tank tends to kill pathogenic organisms.

Crude sewage	- - - -	5,011
Septic tank	- - - -	2,130
Cameron tank	- - - -	2,099

And in another series—

Crude sewage	- - - -	45,600 per cc.
Septic tank	- - - -	3,433

Keeping the septic tank liquor for two days, the number had gone down to 2,025 per cc.

With the finding of the experts that before going into the contact beds the suspended matter must be removed by sedimentation, that if any passes over, it must be retained as far as possible on the surface of the bed, that the surface of the beds must be raked over from time to time and that periodical intervals of rest must be allowed, I agree from experience gained from experiments with contact beds. But the experience is hardly long enough to enable us to say definitely that the septic tank is the best means of bringing about the sedimentation and the destruction of the solid material of sewage. Rest is essential for reasons before stated. But the length of the rest, or in other words how long contact beds will have to be thrown out of work, and what provision must be made for this, are points which demand prolonged observation. With regard to the recommendations of the experts concerning storm water, I agree that it is essential that it should be treated. My observations of storm water at West Derby show that there are a very large number of organisms present, and that rapid filtration only effects a partial reduction in the number. There is no doubt, however, of the beneficial effect of the filtration, but it should be made as perfect as is the case for ordinary sewage. This is not difficult, seeing that the storm water beds will not be constantly used, and that therefore there will be long periods of rest for recuperation.

The treatment of storm water must be made as perfect as that of ordinary sewage.

The experts finally conclude that the bacterial system is the best method for the Manchester sewage; that there should be double contact beds; and that the sewage should first be treated in the septic tank.

There is no doubt that this method yields good chemical results. Bacteriological analyses show that the first contact bed (Bed A) yields 331,700 bacteria per c.c., and 1,420 B. coli per c.c. The final contact bed (Bed D) gives 115,100 bacteria per c.c. and 329 B. coli per c.c. Speaking broadly, the experts say that in the first contact bed 50 per cent. of the dissolved impurity is removed, and in the final (second) contact 50 per cent. of the impurity still remains, and I might say the same bacteriologically.

Taking the B. coli as index of direct fœcal contamination and as index of the other pathogenic bacteria of which we are aware, I have pointed out that the Manchester sewage compares favourably with other sewages as regards the number of B. coli; that these organisms undergo a still further reduction in the septic tanks and finally, an effluent is yielded from the second contact bed, which contains the B. coli in still fewer quantity. From the information which we have gained from our River Severn experiments, I do not think that 300 B. coli per c.c. passing into the Ship Canal will cause harm. At present the Ship Canal contains some 6,000 B. coli per c.c. above the sewage outfall. Accepting the 300 B. coli per c.c. as an admissible limit, can this standard be maintained? The experts, as I have already shown, state that no solid organic impurities must go on the beds. The septic tank, as at present worked, is not preventing this, and further precautions will have to be adopted. Not only does solid material find its way from the septic tank on to the beds, but the effluents from these still contain a considerable quantity of solid matter in suspension. Thus, in one experiment in 1220 c.c. of

Crude sewage there were	3·6 c.c. deposit,			
Septic tank	"	"	1·7	" "
Bed A	"	"	·5	" "
Bed D	"	"	·7	" "

The nature of the Ship Canal has to be taken into account, and every means adopted to prevent solid matter reaching it. This appears to me to be, in this case, quite as important as the presence of the B. coli. It is clear, therefore, that further observation of the septic tanks and the contact beds is necessary.

APPENDIX.

TABLE showing the NUMBER of BACTERIA and of B. Col. Comm. per c.c. and the presence of the B. Enteriditis Sporogenes.

MANCHESTER.

December 5th, 1900.

Sample.	No. of Bacteria per c.c.	B. Coli Comm. per c.c.	B. Enteriditis Sporogenes.
Open sewage tank effluent.	1,000,000	Absent in 0·001 c.c.	Present in 0·1 c.c. Absent in 0·01 c-c.
Average sample from first contact bed.	331,700	1,400	Present in 0·1 c.c. Present in 0·01 c.c.
Cameron tank effluent	1,534,000	1,000	Present in 0·1 c.c. Absent in 0·01 c.c.
Roscoe coke bed effluent.	634,000	3,100	Present in 0·1 c-c. Absent in 0·01 c.c.
Roscoe cinder bed effluent.	550,000	4,870	Present in 0·1 c.c. Present in 0·01 c.c.
Roscoe burnt ballast bed effluent.	456,700	3,800	Present in 0·1 c.c. Absent in 0·01 c.c.
Average sample from final contact bed.	90,000	100	Present in 0·1 c.c. Absent in 0·01 c.c.
Ditto. December 6th -	130,000	288	Absent in 0·1 c.c.
Ship Canal above Barton Lock.	3,900,000	6,100	Present in 0·1 c.c. Absent in 0·01 c.c.
Sewage outfall into Ship Canal.	1,800,000	3,750	Present in 0·1 c.c. Absent in 0·01 c.c.
Ship Canal below sewage outfall	2,434,000	3,800	Present in 0·1 c.c. Present in 0·01 c.c
April 3rd, 1900.			
Raw sewage - -	—	45,000	Absent in ·001 c.c.
Septic tank effluent -	—	2,025	Atypical present in ·1 c.c.
Contact bed A -	—	1,441	
Contact bed D -	—	659	Absent in ·01 c.c.

TABLE showing the effect of the Septic Tank on B. Coli, MANCHESTER and LEEDS.

MANCHESTER.

Plated	Crude Sewage.	Open Septic Tank.	Cameron Tank.
Dec. 6th, 1899 -	—	1,000	1,000
" 12th, " -	5,300	2,833	—
13th, " -	1,335	4,080	4,920
16th, " -	20	100	1,400
18th, " -	4,567	3,267	—
19th, " -	3,833	1,500	1,077
Average -	3,011	2,130	2,099

LEEDS.

Plated.	Crude Sewage.	No. 1 Open Septic Tank.	No. 2 Open Septic Tank.	Cameron Tank.
Dec. 16th, 1899 -	150 (settled)	4,717	4,750	2,483
" 14th, " -	—	8,950	8,050	6,550
" 15th, " -	—	4,367	333	1,650
" 19th, " -	13,450	—	—	—
Jan. 9th, 1900 -	37,867	9,967	3,167	14,933
" 10th, " -	1,267	2,133	367	1.400
" 13th, " -	633	8,900	5,167	9,533
" 16th, " -	64,033	13,133	6,100	8,933
" 17th, " -	11,200	5,300	3,433	—
Averages -	16,807	4,058	4,296	6,497

THE EFFECT OF STAGNATION UPON THE NUMBERS OF BACTERIA AND B. COLI COMMUNIS.

The Bacillus Coli tends to diminish when kept in sewage.

The supernatant fluids of the samples of crude sewage, Septic Tank No. 1 and Beds "A" and "D" (kept from the 3rd to the 18th April) have been examined for the numbers and for the presence of the bacillus coli communis.

Bacillus coli communis, absent in $\frac{1}{10000}$ per c.c. in crude sewage.
Bacillus coli communis, absent in $\frac{1}{10000}$ per c.c. in septic tank.
Bacillus coli communis, present in $\frac{1}{100}$ per c.c. in Bed "A" less than five.
Bacillus coli communis, absent in $\frac{1}{10000}$ per c.c. in Bed "A".
Bacillus coli communis, absent in $\frac{1}{100}$ per c.c. in Bed "D".

TOTAL NUMBER OF ORGANISMS PER C.C.

Crude sewage contains - - -	96,000,000
Septic tank effluent contains - - -	80,000,000
Bed "A" contains - - - -	9,600,000
Bed "D" contains - - - -	6,400,000

In beds "A" and "D" the putrefactive bacilli, *Bacillus fluorescens* and *Bacillus luteus* predominate. These are absent in the septic tank effluent.

It will be observed that whereas the Bacillus coli is considerably diminished by keeping, the multiplication of other forms of bacteria has very greatly increased. It is also worthy of note that the putrefactive forms like the Bacillus fluorescens increase in the beds.

EXAMINATION of the SLUDGE of the OPEN SEPTIC TANK and the PRECIPITATION TANK at Manchester.

By means of six specially constructed glass tubes we made a very thorough examination of the contents of No. 1 Open Septic Tank.

The bottom was covered with sludge to a variable but very considerable depth. It was greatest in amount near the entry of the sewage and was least where the effluent ran off. By means of the glass tubes a sample of the sludge was brought to the surface and portions reserved for microscopical and bacteriological analysis

Microscopical Analysis of Sludge.

Bottom of Sludge of Open Septic Tank.

Colour intensely black, strong tarry odour, develops gas. Microscopical examination shows the deposit to be largely composed of amorphous black granular material, vegetable fibre, wool fibre, cellular tissue ; the vast bulk is amorphous. Cover slip preparation shows a few scattered bacteria and threadlike forms. The number of bacteria is by no means great. A striking feature of the preparation is the absence of any large number of organisms.

Top of Sludge of Open Septic Tank.

The sample is much thinner, with a faint sewage odour. The reaction of the sludge appears to be neutral.

A microscopical examination of the deposit shows much amorphous material. There are, however, more fibres present, cellular debris of various kinds ; sarcinæ and loose cellular tissues are also present. There is a considerable amount of gritty material. The number of bacteria is not great.

A stained cover slip preparation shows that the bacteria are more numerous than in the preceding case. There is still the absence of zoogloea masses.

The dried sludge of the open septic tank burns readily on heating and produces a luminous flame.

Twelve grammes of fresh wet sludge yield after two days drying, 1,442 grammes, and after incineration, ·814 grammes.

Sludge of Precipitation Tank.

Sludge collected as before with the special glass tubes, lighter in colour, distinct tarry odour.

Microscopical examination shows a very much lighter deposit, numerous infusorial forms, vegetable debris, but not as abundant as in the preceding case, wool fibre, threadlike bacteria, one or two diatoms.

I evaporated to dryness the sludge from the precipitation tank, No. 2, and obtained a residue, which like that from the septic tank, yielded luminous gas on heating. It was noteworthy that the sludge had a much more unpleasant decomposing odour than the sludge from the open septic tank.

600 c.c. of the effluent obtained from the following tanks were centrifugalised and yielded :—

Open septic tank - -	·7 cubic centimetres.	
The Cameron - -	·5 „	„
Precipitation tank -	·1 „	„

EXAMINATION of the SUSPENDED MATTER in the OPEN CLOSED and PRECIPITATING TANKS at MANCHESTER.

Samples taken from No. 1, Open Septic Tank ; No. 2, Precipitation Tank, and No. 3, Cameron Tank.

A quantity of the supernatant fluid of each tank was allowed to stand for 12 hours.

Cameron Tank Effluent - -	Deposit black.
Open Septic Tank - - -	Deposit not so dark, but thicker.
Precipitation Tank - -	Lightest.

MICROSCOPICAL ANALYSIS of DEPOSIT of OPEN SEPTIC TANK LIQUOR.

The deposit consists of dark and amorphous granular matter. A considerable number of unicellular green algæ are present. There are no zoogloea masses. Very long threadlike forms of bacteria and remains of wool fibre are present.

The deposit, on the whole, is in a very finely subdivided state, and there is very slight evidence of the original structure of the material from which it is derived. The amount of gritty material seems small.

On addition of potassic ferrocyanide and H.Cl. the greater proportion of the amorphous granular particles give a Prussian blue reaction.

On making a cover glass film of the deposit, and staining with methylene blue, a considerable number of bacteria are demonstrated. There does not appear to be an excessive growth of one particular kind of organism.

DEPOSIT from CAMERON TANK LIQUOR.

Microscopical examination of the deposit shows that the particles are darker than in the open septic tank. They are quite amorphous with the exception here and there of a piece of wool fibre. There are no green unicellular algæ. The threadlike organism is absent and the number of bacteria appears much less. Deposit gives a Prussian blue reaction.

Cover slip preparations stained with methylene blue show a few of the threadlike organisms and bacteria scattered about, but by no means in large numbers nor so abundant as in the case of the open septic tank.

DEPOSIT from PRECIPITATION TANK LIQUOR.

Deposit much lighter in colour, with here and there black granular material. Signs of life much more evident. Unicellular organisms fairly abundant. More evidence of the material of which the sewage is composed, than in either of the preceding cases.

COVER SLIP PREPARATION.

Bacteria much more numerous. Bacteria of all kinds are present. Threadlike organisms, and very numerous short forms, spore forms, spirilla and capsule forms.

April 3rd, 1900.

EXAMINATION OF EFFLUENTS AND DEPOSITS FROM CRUDE SEWAGE, SEPTIC TANK NO 1, AND BED "A" AND BED "D."

Samples have been remaining from the 3rd to the 18th in stoppered bottles which were completely filled with the effluents. Deposits have been thrown down in all bottles and these have been reserved for centrifugalisation. The supernatant fluid in the crude sewage and septic tank has a distinctly tar-like odour and is not unpleasant. That from bed "A," although it is much clearer than the previous effluents and contains much less deposit, yet smells more unpleasantly and has distinctly putrefactive odour. The supernatant fluid from bed "D" is very clear and has a curious grass-like odour. The contrast between the odours of the open septic tanks and the beds is very marked therefore.

DEPOSITS.

Whilst the deposit of the septic tank is very black and abundant, the deposit of bed "A" is very much less, but is still black. The deposit in the case of bed "D' is slight and contrasts with the previous deposits in having a light brown colour and being much more gelatinous, more flocculent and not so heavy.

CENTRIFUGALISATION OF 1,220 C.C. OF THE FOLLOWING FLUIDS YIELDED :—

Crude Sewage - -	3·6 Cubic Centimetres.	
Septic Tank - -	1·7 „	„
Bed "A' - - -	0·5 „	„
Bed "D" - - -	0·6 „	„

The deposit of bed "D" is brown in colour

R. Boyce.

18 July 1900.

18th July, 1900.

An Examination of the two Reports on the proposed New Sewage Disposal Scheme for Manchester, by Dr. G. McGowan, together with some notes of further chemical work in connection with this by Mr. Frye and himself. Written for the Royal Commission on Sewage Disposal, July, 1900.*

Note.—The more purely critical parts of this paper are indicated by a double black line || *at the margin of the paragraph.*

A Summary of the Reports may probably be of some use. They are, however, already very condensed, and to make a summary which is appreciably shorter than the Reports themselves is no easy task. It is therefore hoped that those members of the Commission who have not yet had time to read the Manchester reports, may be able to do so after looking over these notes. A careful study of them, together with Mr. Frye's and my own independent observations and experiments, has left on my mind the impression of the great value of this systematic piece of work, and also of the success which has in the main attended it.

The first Report is dated October 30th, 1899, and is written by Mr. Baldwin Latham, Prof. Percy F. Frankland and Prof. W. H. Perkin, the three Experts consulted by the Rivers Committee. The Supplementary Report is dated December 22nd, 1899, and is written by Mr. Gilbert J. Fowler, under whose able superintendence the experimental work has been carried out; this last includes the records up to December 7th, 1899.

Report. — p. 2. After consultation and inquiry the Experts came to the conclusion "that the only one (scheme) which it was desirable to consider in more detail was the so-called 'Septic Tank' system of Messrs. Cameron, Commin and Martin, of Exeter, and we subsequently arranged that a complete experimental installation should be erected at Davyhulme, according to the plans and under the immediate supervision of the patentees, and the prosecution of exhaustive experiments with the plant so erected has formed an integral part of our inquiry."

pp. 2-3. Visits were made to a number of different sewage works, and the various methods of purification were afterwards summarized, but only the last sentence of this summary need be quoted here :—

> "Thus, for the destruction of impurity, *i.e.*, for the real purification of sewage, there is only one practicable means available, viz., *the employment of bacteria in some shape or form. In fact, all methods of sewage purification actually practised are bacterial methods, whether so named or not.*"

p. 4. On page 4 of the Report, details are given of the amount of land, &c., available at Davyhulme. The ground extends to 165·5 acres, more than amply sufficient, in the opinion of the Experts, for the proposed bacterial scheme. The possibility of utilising the existing works and the special circumstances of Manchester, more particularly the relation of the sewage works to the Ship Canal, were borne steadily in mind.

The present treatment (in bulk) of the Manchester sewage consists in precipitating the screened sewage with sulphate of iron and lime. The liquid, after the precipitate has settled, is run into the Ship Canal, while the sludge is discharged by a sludge steamer into the sea below the Mersey bar. The inadequacy of this treatment has long been the subject of complaint by the Mersey and Irwell Joint Committee, hence three other methods have been considered, viz. :

(1.) Treatment of the effluent on land.
(2.) The Culvert Scheme.
(3.) The Bacterial Scheme, as proposed by Sir H. Roscoe, and modified by the present Rivers Committee.

p. 5. (1.) The possibility of *land treatment* is discussed, but set aside owing to the great initial cost, and the unsuitability of any land likely to be available for the purpose.

p. 6 (2.) The *Culvert Scheme* is likewise rejected, because of (a) the possible nuisance which would be caused in the Mersey; (b) because it would involve the abstraction of 25,000,000 gallons of liquid per day from the Ship Canal; and (c) because of the difficulty (as regards volume) that would be caused by storm water.

Report. — p. 7. The *Bacterial Scheme* was, therefore, found to be the only one to investigate more thoroughly. After reference to the valuable experimental results obtained by Sir Henry Roscoe, and afterwards by Mr. Fowler, in 1896–7, it is pointed out that this plan (of treating chemically-precipitated sewage on bacterial filters) would necessitate, on the large scale, an outlay of 5,000*l.* pe annum for chemicals, and the disposal of 190,000 tons o sludge. Hence it was sought to devise a more economical method.

"Some of the most urgent points demanding elucidation were the following :—

> "1. To determine whether the trade refuse in Manchester sewage seriously impaired the efficiency of the bacteriological treatment."
> "2. To determine whether a portion, at any rate, of the sludge can be destroyed by bacterial agency."
> "3. To determine whether the addition of chemicals to the sewage before bacteriological treatment can be dispensed with."
> "4. To determine whether the aerobic process . . . or a combination of aerobic and anaerobic processes is the more advantageous."

To obtain a reply to these questions, experimental bacterial beds were erected at Davyhulme, and those beds were subsequently added to, in order that storm water as well as sewage might be dealt with, in compliance with a demand made by the Local Government Board. The results of these experiments (which are being continued still) "have enabled us to formulate a definite scheme for dealing with the sewage of Manchester in its entirety, which we have no hesitation in recommending to your Committee for adoption."

Pages 9–12 of the Report are taken up with a short explanation of the actions of different kinds of bacteria, and the conditions under which they best do their work of purification. It is hardly necessary to summarize this.

Description of the Experimental Plant.

(Diagrams 1 and 2 and Photograph 1.)

There are five bacteria beds (concrete), A, B, C, D, and E. A, B, C and D are 33·5 feet square at the top, 17·5 feet square at the bottom, and 4 feet deep. E is 12 feet square at the top, 3 feet square at the bottom, and 4 feet deep. The bottoms of the tanks are channelled, to receive the 6-inch and 2-inch pipes for drawing off the filtrate. The filtering medium is clinker, 3 feet deep. With the exception of the rough material immediately surrounding the pipes, the size of the clinkers is uniform throughout each bed and is as follows :—

Bed A, passed 3-inch mesh, rejected by 1-inch mesh.
" B, " 1 " " " " ¼ " "
" C, " ¾ " " " " ¼ " "
" D, " ½ " " " " ⅛ " "
" E, " ½ " " " " ⅛ " "

The troughs for distributing the sewage and effluents upon the beds are of wood, laid upon the surface of the clinker, and perforated near the bottom so as to give an even distribution over the bed. The supply-pipes were so arranged that the beds could be supplied either with *screened raw sewage*, *settled sewage*, or *open septic tank liquor*. After allowing for the slope of the sides, each bed A, B, C, or D had an effective superficial area of 0·0131 acre (*i.e.*, about $\frac{1}{76}$th of an acre).

> Note.—It is perhaps worth while to point out here that in a small bed of the size and shape of A (see figure), having its sides so sloped that the superficial area at the top of the bed is 3½ times greater than that at the bottom, the aërating conditions must be more favourable than in a large bed (say, of half an acre), in which the slope of the sides would be relatively inappreciable.

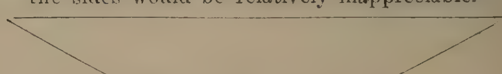

Diagram to Scale.

Treatment of Settled and of Raw Sewage.

During the earlier stages of the experiments, only beds A and B were in operation, their capacities having first been taken (*see* p. 3). For the week ending 21st September, 1898, bed A was filled once a day with

* *Note.*—It is nearly two years since this Report was sent in to the Commission, but it is printed now with little change, only a few small additions and alterations having been made.
May, 1902.

settled sewage and the effluent run on to B, one to two hours' contact being allowed · while from 21st September to 26th October two fillings per day were allowed. A and B having now acquired a high degree of efficiency (as shown by the analyses of the effluent), they were, after 26th October, 1898, filled three times a day with settled sewage, according to a given time table.

Owing to the highly satisfactory results obtained with settled sewage, it was felt that the time had now arrived for ascertaining whether the *raw sewage* of Manchester could be effectively dealt with on the same lines. From 16th November till 14th December, 1898, therefore, raw sewage was run on to the beds at 6 a.m., the other two fillings still consisting of settled sewage. The results with three fillings under those conditions still proving satisfactory, it was decided to experiment with raw sewage entirely, and from 21st December, 1898, to 7th February, 1899, raw sewage alone was admitted. After the latter date it was decided to try the effect upon the bed of *four fillings a day*. For the first week raw sewage was used, but afterwards settled sewage, as it was found that the surface of bed A showed signs of clogging; and this system of working (*see* time-table) remained for the most part in use until the date of the Local Government Board enquiry on 1st May, 1899.

As the treatment of both raw and settled sewage has been abandoned at Manchester (because of the above clogging), nothing further need be said here on the subject.

On December 3rd, 1898, the small extra (fine) bed E was added, which was filled with effluent from B by pumping. It was supplementary to A and B, and its use was discontinued after April 12th, 1899.

The beds C and D were brought into operation on *April 13th, 1899*, C being filled twice a day with settled sewage, and two hours' contact being allowed for each bed.

D was taken up in May, 1900, in order to re-arrange the pipes at the bottom of the bed. C, I think, has never been touched. I understand that Mr. Fowler is supplying to the Commission full details of the working of the beds since the Reports were published.*

After April 10th, 1899, a sunk wooden partition was placed in the settling tank, to keep back suspended matter as far as possible. Previous to this, much had been carried on to the first contact beds.

Measurement of Capacities of Beds A and B.

The beds, when empty, had each a capacity of 10,580 gallons. After the cinders were filled in, the capacities were :—

	A.	B.
September 9th, 1898 -	—	5,688 gallons.
" 12th, " -	5,688	— "

On using, the capacity of A went down gradually as low as—

April 13th, 1899 - - -	3,020 gallons.
April 20th, " - - -	3,350 "

B showed less diminution, as was of course to be expected, seeing that it treated the effluent from A, the lowest point being reached on—

March 7th, 1899 - - -	3,700 gallons.
April 20th, 1899 - - -	4,350 "

The beds had short rests given to them now and then, in addition to the daily rests between the fillings.

The quantities of sewage (settled or raw) dealt with by A and B between September 12th, 1898, and April 20th, 1899 (calculated from the capacitities of bed A at different times), were :—

	Gallons per acre per day.
Maximum, October 27th, 1898 - -	616,981
Minimum, January 10th, 1899 - -	490,499
On April 20th, 1899 - - - - -	574,135
Average of ten gaugings between September 12th, 1898, and April 20th, 1899 - - - - - -	557,313

From his observations on the Leeds beds Mr. Frye thinks that the gain in capacity of a bed, after resting, is due mainly to mechanical shrinkage of the spongy matter present, and only in a lesser degree to oxidation. He bases this view on the fact that the proportion of volatile to non-volatile matter in different sludges—whether these be taken from the interior of a filter bed or from a septic tank—is much the same for a given sewage. (See notes to Appendix F.)

On the other hand, the examination of filter bed gases shows that oxidation goes on actively when a bed is resting. Report.

* *Note.*—For further details upon this point, see the Annual Report of the Manchester Rivers Department for the year ending March 27th, 1901, pp. 61-62. (G.M.—May, 1902.)

The Septic System of Sewage Purification (Cameron, Commin and Martin's patent).

The closed tank used in these comparative experiments is 40 ft. long, 12 ft. wide, and 9 ft. 2 in. high, having an arched roof. From the septic tank, the liquid passes into a shallow aerating trough, over the sides of which it falls in thin sheets into a channel leading to distributing wells, and so on to the beds, which are filled and emptied automatically. There are *six* beds, enclosed by vertical concrete walls, the average area of each bed being 294 square feet, or about 33 square yards (they differ slightly in size). The filtering medium (clinker) is 4 ft. deep, and is arranged from the bottom upwards as follows :— p. 14.

1 ft. to pass 3 in. mesh, rejected by 1 in. mesh. p. 15.

2 ft. 9 in. to pass ¾ in. mesh, rejected by ⅛ in. mesh.

3 in. of residue which passed ⅛ in. mesh.

This installation was got into working order by November 10th, 1898, but difficulty was experienced in adapting the automatic gear to the requirements of the experimental plant; consequently the filling and emptying of the beds was mostly done by hand. The beds were, of course, started gradually, the charges being increased until, from March 17th to April 29th, 1899 (the day of the Local Government Board inquiry), the installation was working eighteen hours per day. p. 19.

Measurement of Bed No. 6 of Septic Installation. p. 24.

	Capacity.	Gallons per Acre per Day.
November 8th, 1898 - -	3,560	—
" 9th " - -	3,330	493,333
April 28th, 1899 - - -	2,820	835,555
September 8th, 1899 - -	2,480	734,814

Roscoe Filters (treating *chemically precipitated* Sewage). p. 15.

These filters are two in number. They were constructed under the advice of Sir Henry Roscoe, and first put into operation on *December 15th, 1895*. After December 15th, 1898, they received four fillings per day. Each filter bed measures 12 ft. 6 in. by 18 ft., giving a surface area of 25 square yards ($\frac{1}{194}$th of an acre). They were filled originally to the depth of 3 ft. with the filtering material, in the one case coke and in the other cinders, graded as follows (beginning with the bottom layer) :—

12 in. rough clinker.

9 in. clinker screened to pass 1½ in. mesh.

6 in. " " " ¾ in. "

6 in. " " " ⅜ in. "

3 in. washed gravel.

Capacities of the Roscoe Filters. p. 21.

	Coke Filter.	Cinder Filter.
At the commencement :	Gallons.	Gallons.
Dec. 19th, 1895 - - -	1,750	1,750
April 26th, 1897 -	1,296	1,260
Oct. 6th, 1897 - - -	1,296	1,264

The full table of capacities given in the Report shows that these filters are now keeping a practically constant

Report. p. 27

capacity. It is noteworthy that by the beginning of this year their depth had increased from the original 3 ft. to 3 ft. 6 in., from the gradual accumulation on the surface of soil produced from the sewage.

The *quantity* of chemically-precipitated sewage dealt with per acre per day in these filters varied between :

———		Coke.	Cinder.
		Gallons.	Gallons.
Maximum, Dec. 19th, 1895		1,016,000	1,016,000
Minima	June 17th, 1898	690,100	—
	April 26th, 1897	—	731,800
	Oct. 6th, 1899	1,004,000	947,800
Average (16 gaugings)		831,400	877,100 (15 gaugings).

On pp. 24–25 of the Report, the foregoing measurements of capacity of the several bacteria beds which were being reported on are summarized and deductions drawn. The following paragraphs may be quoted here :—

"(1.) With regard to the most advantageous grade of material, experience has shown us that the coarse cinders with which bed A was filled permit the free access of sludge, both into the body of the bed and even into the drains below, which sludge not only diminishes the capacity, but is also prejudicial to the purifying efficiency of the bed. On the other hand it is well known that if the material is too fine, the beds soon become quite impervious to sewage. In view of these considerations, we have endeavoured in the case of beds C and D to select material of such grade as shall be free from either of these defects."

"(2.) Respecting the decrease in capacity of a bed noticed in the early period of working, it was observed that the surface of the bed sank . . . . some two inches during the first month, necessitating the addition of a layer of fresh cinders to make the depth of the bed up to the original three feet. This settlement of the material doubtless partly accounts for the early decrease in capacity."

"(3.) . . . . . The spongy bacterial growths also necessarily occupy space, and retain a considerable volume of liquid."

"(4.) As far as time has allowed, it would appear from our experiments that contact beds, after a comparatively short space of time acquire a practically constant capacity, and this conclusion is borne out by the experience gained over a much longer period of time with the Roscoe filters, the measurements of which on April 26th, 1897, and April 26th, 1899, gave identical results."

This analogy between the Roscoe filters and the other contact beds is open to criticism. The former treat chemically-precipitated sewage, from which the iron and tough fibre are presumably settled out.

"It was noted in the case of the Roscoe filters that after the period of constant capacity had set in, the surface of the bed had visibly risen above its original level, and that the layer at the top had become converted more or less into the condition of soil. If the surface when in this condition is allowed to remain too long
p. 37. untouched, it tends to prevent the free percolation of sewage into the body of the bed. On being loosened, however, with a fork, the sewage penetrates into the interior quite freely. This treatment has not been found necessary more than once a month.'

The authors then drew the conclusions :—

"(1.) The suspended matter must be removed as far as possible by sedimentation.

"(2.) Any suspended matter not so removed should be retained as far as possible on the surface of the bed.

"(3.) For maintaining the efficiency of such beds, the surface must be raked or forked over from time to time.

"(4.) Periodical intervals of rest must be allowed.

Chemical Efficiency of the Bacterial Beds.

In order to arrive at this, the sewages, septic tank liquors and effluents have been continuously sampled* and analysed, the results being set forth in a series of diagrams which are easy to follow. The tests which are mainly relied upon are :—

(1.) The 4-hours "Oxygen absorbed" test. *Diagrams 4, 5 and 6.*

(2.) The albuminoid ammonia test. *Diagrams 7, 8 and 9.*

(3.) The incubator test. *Diagrams 10, 11 and 12.*

This last test, devised by Mr. Scudder, is now well known ; but the description of it which is given in the Report may be appended here :—

"A very valuable indication of the degree of impurity of any sewage or effluent is afforded by the so-called incubator test. To carry this out, a determination is first made of the oxygen absorbed from potassium permanganate by the sample in three minutes. A bottle is then completely filled with the sample, and closed and placed in the incubator at 80° F. for six or seven days. The three minutes' oxygen absorption is then again determined. If any putrefaction has taken place, the oxygen absorbed in three minutes will exhibit a decided increase in amount, owing to the more ready oxidizability of the products of putrefaction, such as sulphuretted hydrogen, etc. On the other hand, if the sample keeps sweet, the three minutes' oxygen absorption remains practically unchanged after incubation, or there will be a slight decrease, owing to slight oxidation of the impurities which has taken place during the period of incubation at the expense of the nitrate or dissolved air present in the sample."

Reserving any definite expression of opinion as to the general applicability of the incubator test, it appears to have answered very well with these Manchester effluents.

In addition to the above three tests, the diagrams and tables also give information with regard to the amounts of free ammonia, nitrite, nitrate and chlorine, and also the degree of acidity or alkalinity of the liquid in question. Besides this, a note is made at the top of each diagram of the trade effluents which at any particular date were conspicuously present in the sewage. The diagrams further indicate :—

(*a.*) Whether the sewage dealt with is settled or crude.

(*b.*) The volume of sewage flow per 24 hours.

(*c.*) The impurity in the raw or settled sewage, first effluent from bed A, and second effluent from bed B, in terms of "oxygen absorbed," etc.

(*d.*) The Mersey and Irwell standards.

It will be remembered that the Mersey and Irwell standard is, "*that a gallon of a final effluent shall not show more than 1 grain of 'oxygen absorbed' in four hours, and not more than 0·1 grain albuminoid ammonia.*"

The results of the treatment of raw and settled sewage by the double contact system, as set forth in the report and the diagrams already referred to, were encouraging, but not by any means all that could be desired, the Mersey and Irwell standard being frequently infringed by the final effluent. As may be inferred from the later Manchester experiments, this was no doubt due in great part to the unevenness in composition of the sewage, and the consequent strain upon the filter beds at certain hours of the day ; and to the clogging of the first contact bed. It seems, therefore, hardly worth while to enter into any detailed criticism of these results here, since the Manchester experts, recognising the causes of the above partial failure, long ago gave up the idea of treating raw or settled sewage in favour of septic tank liquor (*see* page 7). They refer, however, at this stage of the report to one or two points which it is well to notice, especially to the fact that the oxidizable matter in the Manchester sewage (as indicated by the "oxygen-absorbed" test) often consists largely of special forms of trade refuse, which are harmless from a putrescible point of view. Thus, several of the final effluent samples, which infringed the "oxygen-absorbed" standard, withstood putrefaction on being submitted to the incubator test.

* Note.—In answer to a question as to how this sampling was done, Mr. Fowler writes (June 10th, 1902) :—
"Comparative samples were obtained in all these cases as follows :—
"The penstocks were so adjusted that the beds filled and discharged at a "constant rate. Samples were then taken every five minutes, and a "mixture of these samples was analysed."

They add : "Indeed it should be clearly borne in mind that the limits of impurity must not be too rigidly interpreted, and that the object of purification is primarily the production of an effluent free from putrescibility, and not one in which the chemical ingredients are below some necessarily more or less arbitrary standard. It was at one time feared that the presence of the manufacturing refuse in Manchester sewage would seriously militate against its successful bacterial treatment, but reference to the diagrams clearly shows that this is not the case, and that the trade refuse present in the sewage is incapable of inhibiting the bacterial process."

"It has indeed been found by one of us, in the course of experiments made in connection with the treatment of sewage from other towns, that certain trade effluents which, like those from tar works, would be expected to exercise a markedly deleterious influence on bacteria, are, when only moderately diluted, without any perceptible influence on bacterial life. Indeed we are of opinion that only in very exceptional cases can trade refuse be present in ordinary town sewage in such proportion as to affect the bacterial processes of purification."

These early experiments also showed that the effluent became better as the beds got older; that, when the sewage was exceptionally weak, only one contact was required; and that, when the cinders in the first contact bed were *too coarse*,* the bed became more or less clogged with suspended matter and failed to do its work properly.

Efficiency of the Cameron Septic Tank Installation.

Diagrams 13 and 14 show that the liquor from the closed septic tank, unlike crude sewage, remains comparatively uniform in composition, being similar in this and other respects to the liquors from the open septic tank. "The filtrate from the contact beds of the septic system is characterized by its frequent, we might almost say its uniform, infringement of the Mersey and Irwell standards; while, on the other hand, it generally resists putrefaction in the incubator test, in consequence of its containing a comparatively high proportion of nitrate.

Efficiency of the Roscoe Filters.

The earlier results from these have already been given in Reports 1896, 7 and 8 (cited). The results obtained in 1898 and up to 17th May, 1899, are given in *Diagrams 15, 16, 17, 18 and 19.*

"An Examination of these shows that although the numerical limit of impurity of the Mersey and Irwell Joint Committee is at times infringed, yet this infringement is not serious.

"The results of the incubator test are uniformly satisfactory, showing that the filters are effective in removing putrescible matter.

"After 15th December, 1898, the filters were filled four times a day, but no appreciable difference in the amount of purification effected is revealed by the curves.

"This result is of importance as bearing out the statement that, as the actual holding capacity of the beds decreases (within a certain limit, of course), the chemical efficiency increases, and a larger amount of work can therefore be put upon them. With four fillings per day (Report, p. 22) the beds are dealing with as much tank effluent as they did when first started, and the chemical results are, if anything, more satisfactory. (*Compare remarks on p. 5.*)

"The cinder filter has, with some incidental exceptions, given better results throughout than the coke filter."

Later Improvements on the Foregoing Methods of Bacterial Treatment, *i.e.*, Introduction of the Open Septic Tank.

Leaving out of account for the moment the Roscoe filters and the Cameron closed septic tank installation, it will be observed that up to this point the Report has dealt with the treatment either of settled sewage or of raw sewage on the bacteria beds. After this, the results obtained by treating *open septic tank liquor* on the beds are given. *And this last is the plan which it is now proposed to adopt on the large scale.*

* Note.—In answer to a recent query with regard to this point, Mr. Fowler writes (May 14th, 1902):—

"I should consider a bed *too coarse* which contained no material below ¼ inch. The grade of a bed is really conditioned by the size of the smallest material present, and the proportion of this to the whole bulk. Our material for the (new) half-acre beds is screened through a $\frac{3}{16}$ inch mesh, and roughly graded by raking down the coarser pieces to the bottom of the bed, as the material is tipped from the wagons."

The objects aimed at in using an open septic tank were to deposit the inorganic detritus and as much of the suspended organic matter as possible, and to get a tank liquor of fairly uniform composition; this, after being subjected to anaerobic decomposition in the tank, would be more ready to undergo subsequent nitrification. Beds A and B were also remodelled. The drain pipes of B had become blocked with fine material, so the pipes both of A and B were replaced by perforated glazed socketed pipes surrounded by 6 inches of coarse clinker, while the surface of the bed was covered by 3 inches of fine material. The body of A was filled up with clinker which passed a ¾ inch mesh but was rejected by ⅛ inch mesh. Bed B was refilled with its old clinker, *i.e.*, clinker which passed a 1 inch mesh, but was rejected by ¼ inch mesh. Report.

Beds A and B, as they stand at present, therefore date from August 18th and 22nd, 1899; C and D from April 13th, 1899; and D (relaid) from May, 1900.

On February 16th, 1899, raw sewage was allowed to flow through a by-pass* into No. 1 precipitation tank (which has a capacity of 1,125,000 gallons), and it continued to do so with only a few interruptions of an hour or two's duration until May, 1900, *i.e.*, from 14–15 months, when the tank had to be cleaned out, being two-thirds full of sludge.† As a rule the flow through the tank was such that the water just passed over the sill at the north end in a very fine stream, and this was found on measurement to amount to 1,700,000 gallons per 24 hours. *The stay of the liquor in the tank was therefore about 16 hours.* The usual scum gradually formed until it covered the entire surface of the liquid. p. 36.

After April 27th, 1899 (*i.e.*, 2½ months after starting), the liquor from the open septic tank was led on to beds A and B. The first results were not quite satisfactory, partly owing to A being faulty, and to the fact that the beds had hitherto been accustomed to raw sewage. But generally speaking, the final effluent complied with the Mersey and Irwell standard. p. 37.

* It is to be noted that this by-pass is 1ft. 6in. above the invert of the sewer, the average depth of sewage in the pipe being three feet. Even allowing for the fact that the sewage, by the time it reaches Davyhulme, has travelled about six miles, and has therefore got well broken up, one would think that this 18in.-high outlet pipe would hardly deliver an average sample of the sewage into the tank. There would probably be less that a proportionate amount of the sediment withdrawn. The point is worth noting, because this would affect the time required for the silting up of the septic tank.

Since the foregoing paragraph was written, Mr. Frye has drawn samples of the crude sewage at different depths in the culvert, at a point about 80 yards above the inlet pipe to the open septic tank, and has analysed them with the following results:—

—	Bottom of Sewer.	Half way up (*i.e.* 1 ft. 6 in.)	Top of liquid in Sewer.
Parts per 100,000.			
Total suspended matter - - -	47·1	48·3	55·5
Consisting of:—			
Inorganic matter - - - -	14·3	14·2	14·2
Volatile „ - - - - -	32·8	34·2	41·3
	47·1	48·3	55·5

A great many such estimations would have to be made before any conclusions could be drawn with regard to this. But, contrary to what one would have expected, these analyses show no difference in the percentages of detritus at different depths in the sewer; the larger percentage of organic matter at the top of the liquid was due mainly to grease.

† It is stated in the Report (p. 36) that, up to October, 1899 (*i.e.*, after the tank had been eight months in use), "the only notable quantity of sludge which can be perceived, on dipping with a rod, is immediately beneath the inlet penstocks." But this was probably an under-estimate, for Mr. Frye has found at Leeds that thin sludge in a tank offers no apparent resistance to a rod. The subsequent rapid accumulation of sludge was no doubt partly due to 279 barrows of garbage, which were intentionally tipped in between October 4th and 31st, 1899, in order to see whether the tank was capable of dealing with more solid matter than it received in the course of the ordinary day's flow.

Report. On June 1st, 1899, the effluent from the open septic tank was treated on beds C and D, which, from the 13th of April previously, had only had two fillings per day of settled sewage. The results were excellent (*Table VIII.*) "Recently (*i.e.*, in the autumn, of 1899) it has been found possible to deal with 4 fillings per day, *every single sample of effluent being non-putrescible and well within the limit of impurity.* A large amount of nitrate nitrogen is present in every sample of the filtrate."

Table VI. (Report, p. 37) is of such importance that it is advisable to give it in full:—

"Table VI.

"Showing the quantity of effluent from *open septic tank* dealt with by double contact on beds C and D in gallons per day (depth of acre-bed taken at 3·3 feet).

Date, 1899.	Capacity of Bed C.	Quantity dealt with in gallons per acre per day.	Number of fillings per day.
June 1 - - - - -	3,690	316,203	2
June 8 - - - - -	3,690	474,304	3
July 6 - - - - -	3,690	632,405	4
August 17 - - -	3,250	742,616	8 on C {4 on B, 4 on D}
September 14 - -	2,000	456,994	" "
October 4 (after 18 days' rest) - - - -	3,320	758,610	{4 on C, 4 on A} 8 on D

p. 38. The analyses of the liquor from the open septic tank (*Report, p.* 38; *Table VII.*) showed it to be practically the same as that from the Cameron closed tank; and that it was very uniform throughout—and in this respect very different from the raw sewage—is seen from the following figures (*Suppl. p.* 10). These figures represent a series of hourly analyses, extending over a fortnight.

—	4 hours' Oxygen absorption.		Acidity (relative).	
	Max.	Min.	Max.	Min.
Sewage - -	22·0	3·0	5·20	0·15
Tank liquor -	9·0	4·0	1·00	0·40

(Cf. *also Table I. and Diagrams A to E.*)

p. 38. Page 38 of the Report is taken up with discussing the relative values, as shown by the results, of the Cameron Septic tank system, *i.e. closed tank and one filter-bed contact*, as against *open tank and two filter-bed contacts* (*Table VIII. and Diagrams* 13 *and* 14.) The conclusion at which the Experts arrive is that—

"When both systems are dealing with the same volume of sewage on the same area, the advantage as regards efficiency belongs most indisputably to the double-contact system. We would emphasize that our experiments clearly show that the key to efficiency in the bacterial treatment of sewage is multiple as opposed to single contact."

"We have further quite recently obtained results which indicate that a most important economy may, by suitable management, be effected in the area required for efficient bacterial treatment. Thus, we have found that by mixing the effluent from a first contact bed with that from a second, a liquid is obtained which withstands the incubator test, and which is incapable of putrefaction. *See Table IX.; also Diagrams* 15, 16 *and* 17.)

This is described as "The Method of 1½ Contacts." And, although it is not proposed to make the size of the filter beds conform to this scheme of treatment, the possibility of dealing with the open septic tank liquor in this manner, *if required*, allows for frequent resting of the filter beds and other contingencies.

Supplement p. 11 Again, "latterly it has been found, as the diagrams clearly show, that one contact is in general sufficient to secure adequate purification."

Rainfall at Manchester.

On pages 41-42 details are given of the rainfall at Manchester, and of the rates at which the rain falls. The authors conclude this section thus:—

"In our judgment it is of the utmost importance, as far as possible, in all contemplated works, that the rainfall should be separated where it conveniently can be from the sewers, and that no natural water courses should be conveyed into the sewers."

Experiments on Storm Water.

These experiments were begun on 25th March, 1899, and have been continued since, as opportunity has arisen. (*See Tables XI. and XII.*) They were first carried out in beds A, B, and D, while subsequently C was also worked in conjunction with D. The storm water was always passed first into the small settling tank (for what length of time is not stated), before admission to the beds.

On page 45 the authors summarize the results of those experiments, which they think are the first to have been systematically carried out with storm water, and from this summary a few points may be noted:—

"Detailed analyses of the sewage and estimations of suspended matters show that there is even a greater amount of oxidisable matter in the first flush (after a storm) than in ordinary sewage."

"It is evident that a distinction must be drawn between the first flush of a storm and the highly diluted sewage which follows, the latter alone being properly designated as storm water. . . . The 'first flush' lasts, in the case of Manchester, from two to four hours." (Cf. *Diagram* 20; *also Diagrams* 4 *to* 12.)

"After a heavy and long-continued rain, the sewage may become so dilute as to be within the Mersey and Irwell standard immediately after passing through the settling tanks. Such an effluent would not need to be treated, and consequently such a storm should afford a period of rest to the filtration area."

I should like to take this opportunity of pointing out that a filter effluent and a dilute storm sewage, each showing less than 0·1 part albuminoid ammonia and 1·0 part "oxygen absorbed" per gallon (M. and I. Standard), are very different things. Although I have not yet actually tested the point directly, I should expect (from many experiments on the aëration of effluents) a dilute storm-water sewage, showing 0·1 part albuminoid ammonia and 1·0 part "oxygen absorbed" per gallon, to putrefy on incubation—*i.e.*, to be unfit to run into a reservoir like the Manchester Ship Canal. (I shall investigate this point experimentally later.)* G.M.

A storm has the effect of cleansing the sewers. Hence for some time after a storm the results given by the filter beds are somewhat better than usual.

The authors draw the following conclusions from these storm-water experiments:—

"1. Provision must be made for the storage of the first flush of sewage** at the beginning of a storm.

"2. It is probable that accelerated treatment may be commenced about two hours after the augmented flow has begun to reach the works.

"3. Adequate purification of storm water (*i.e.*, purification such as will make the storm water effluent stand the incubator test) can be effected by short double contacts, or in the case of extreme dilution even by single contacts, the length of the cycle being inversely proportional to the flow of the sewage.

"4. When, after a storm, ordinary treatment is resumed, the beds have been proved by experiment to show no decrease in purifying efficiency."

* *Note.*—Since the foregoing was written, I have diluted a few sewages with tap water down to the M. and I. Standard of albuminoid ammonia (and to less than the proportionate figure for "oxygen absorbed" in most of the cases), and have found that they all became putrid upon incubation.—G. M. (May, 1902).

** Since the Report was published, I understand that the *separate treatment* of the first flush has been decided upon as being the best method, and so the question of storage falls aside.

G. M.

And again :—

"The problem of the treatment of storm water appears to resolve itself into providing a system of rapid treatment continued for a limited time.'

Experiments were therefore made to see whether a bed would effect purification if worked for a limited period in cycles of much shorter duration than the normal, an extended period of rest being afterwards allowed. The results of these experiments were satisfactory. Mr. Fowler comments on the point that a long rest means an increase of nitrate in a bed, and therefore a temporary augmentation of its purifying power.

Beneficial Effect of the Effluent on the Water of the Ship Canal.

A long series of determinations were made by the incubator test, to determine the effect of mixing one volume of Ship Canal water with one volume of a mixture of the four effluents obtained from beds B and D in the course of the day. The result was that the effluents clearly improved the quality of the Ship Canal water, the nitrate in the effluents exerting an oxidising action upon the impurities in the water.

It is not stated in the Report whether the above effluents from B and D underwent any aëration before being mixed. But, even if they did to some extent, I do not think this would appreciably detract from the value of the experiments.

G. M.

Volume and Character of the Manchester Trade Refuse.

This subject is reviewed and the following conclusion is arrived at :—

"The total quantity of prospective trade refuse from all sources does not amount to more than 10 per cent. of the total estimated future sewage flow. The effect of this trade refuse on the purification process is not therefore likely to be of a serious character."

In a list which is given in the Report, showing "the nature and volume of the trade effluents which may in future be admitted to the sewers" (a volume of 2,570,000 gallons is allowed for), no mention is made of iron liquor. If iron liquor is not to be allowed in, the life of the filters will be lengthened (see Appendices E and F). This section is not so clear as the rest of the Report, and it is not quite evident from it whether it is proposed to exclude any trade effluents from the sewers, and if so, which trade effluents.

Temperature of Sewage and Air.

Pages 51—52 of the Report give a number of readings of the temperature of sewage and air at different seasons of the year, as measured at Davyhulme. During the winter months the sewage was warmer by about 10° Fahr. than the air, the average temperatures of the sewage at the outfall, from December, 1898, to April 14th, 1899, being 55·9°, 52·9°, 54·6°, 57·9°, and 54·3° Fahr. From January 24th to February 6th, 1899, very cold weather was experienced, ice being formed on the experimental beds. But "on no occasion has any difficulty been experienced through the small layer of ice which has formed on the surface of the beds. The comparatively warm sewage at once melts the ice, and finds its way into the bed."

MANCHESTER EXPERTS' CONCLUSIONS AND RECOMMENDATIONS.

These are summed up on pp. 35-38 of the Report, and should be read as they stand.

SUPPLEMENTARY REPORT.

On 22nd December, 1899, *i.e.*, seven weeks after the issue of the foregoing Report, a Supplementary Report was issued confirming and extending the results previously obtained. This contains correspondence between the Manchester Rivers' Committee, the Experts, the Local Government Board and the Mersey and Irwell Joint Committee. The Experts adhere to their original recommendations.

Appendix B of the Supplement consists of a number of further interesting experimental results from Mr. Fowler, obtained down to 13th December, 1899; as before, these are illustrated by diagrams. Those dealing with tank sludge and suspended matter in septic tank liquor will be referred to in the last part of this critique. Supplement
Pages 13-16 are full of details of the methods of working the filter beds, so as to get at the most economical plan; *e.g.*, on page 15 it is mentioned that the effluent on the second-contact bed D was allowed to stream slowly through the bed all the time, with the object of saving labour. Pages 17-18 detail experiments on the mixing of the effluents from C and D (the mixed effluent being always kept up to the Mersey and Irwell standard, and also withstanding the incubator test), so as to economise filter-bed area. In conclusion, the following three paragraphs from Mr. Fowler may be quoted :—

"This result (obtained by the mixing effluents from C and D) is of great importance, as showing that only one-fifth of the total acreage (of the proposed new beds) need be at the lower level." p. 18.

"An area of 60 acres will give ample margin for one day's rest in seven, even when the average dry weather flow is taken at 30,000,000 gallons. The present average dry weather flow is found by measurement to be 26,300,000 gallons. A further margin is afforded by the 25 acres of storm beds, which will need to have at least two fillings per day put upon them, in order to maintain their efficiency."

"The above experiments all lead to the conclusion that, for economical treatment of sewage in bacteria beds, it will be found advisable to effect a high degree of purification in a certain portion of the sewage, and mix this (effluent) with another portion less effectively dealt with." p. 19.

The Manchester Reports thus prove quite clearly that from the time when *open septic tank liquor* came to be treated on the filter beds (or, at least shortly after that time), a satisfactory effluent was obtained. A reference to *Appendix A*, which gives the detailed analyses of a few samples drawn on December 5th, 1899, and January 3rd, 1900, shows that the final effluents at those dates were excellent. There was an unavoidable delay in the analysis of the second set of these samples, but this does not affect the general point. It would, of course, be foolish to draw any conclusions from one or two analyses; but, so far as these go, they corroborate the results in the Reports.

On page 8 of the foregoing summary, the comparative evenness in composition of the open tank liquor as compared with sewage, both with respect to "oxygen absorbed" and acidity or alkalinity, is noted. But it was thought advisable to further estimate the amount of organic matter (as measured by the *organic nitrogen*) which the tank liquor contains, and therefore seven further samples, drawn at different dates—most of them by Professor Boyce—were tested for this. The results are given in *Appendix B*. They substantiate the very even composition of the liquor, and also the fact that—fortunately for the Manchester filter-beds—the liquor is weak. *Broadly speaking, it does not contain more than four parts of total combined nitrogen per* 100,000, *two parts of this being organic nitrogen and two parts ammoniacal nitrogen.** The beds have thus a comparatively light task to perform, so far as the destruction of organic matter is concerned.†

The next point to consider was: Given this good effluent, at what cost to the tank and filter-beds was it being produced, *i.e.*, how quickly was the tank sludging up, and were the filter-beds being choked at all, and if so, with what kind of sludge ?

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*Had the liquors been analysed immediately they were withdrawn from the tank, the ammoniacal nitrogen would have been somewhat less and the organic nitrogen correspondingly more than is shown by the actual figures in the appendix.

†Sewage from different places varies so greatly that it is rather hard to say how much organic nitrogen an average tank liquor would show. Probably three to four parts of organic nitrogen and three to four parts of ammoniacal nitrogen would not be far wrong.

Supplement.

p. 9.

1. Destruction of Sludge in the Open Septic Tank, and Sludging up of the Tank.

Mr. Fowler, I understand, calculates that the Manchester tank, in which the stay of the sewage has been only 16 to 11 hours, destroys about 30 per cent. of the original sewage sludge. Careful calculations on the same subject have also been made by the sewage authorities at Leeds, where twenty-four hours is allowed for the "septic" action, and where it is considered that nearly 50 per cent. of the total sludge is dissolved. But both Mr. Frye and I feel that this point—one of the most important of all as regards sewage treatment—requires further experimental investigation. No two sewage sludges are likely to dissolve in a tank to the same extent.

As already stated, the Manchester open tank was cleaned out in May of this year, being then two-thirds full of sludge. But the rate of the flow of the sewage through it had varied. For the first eight months it had been about 1,700,000 gallons per twenty-four hours (giving a stay of about *sixteen* hours in the tank); while on October 18th, 1899, the screen at the entrance to the by-pass from the main sewer was removed, causing a flow through the tank of 2,500,000 gallons in twenty-four hours (equal to a stay of *eleven* hours, in the tank). Then, from October 4th to 31st, 1899, 279 barrows of garbage (collected from the mechanical screens at the entrance to the works) were tipped into the tank, but this had to be stopped, as the destruction was not sufficiently rapid. Between October 31st and December 13th, however, it is stated that a very large portion of the garbage had disappeared, the disintegration of matches, paper, etc., being plainly visible.

Under these circumstances, combined with the fact that the tank received sewage from a by-pass which was 1ft. 6in. above the invert of the sewer, any detailed criticism as to the rate at which the tank would sludge up under normal conditions is hardly possible. So much suspended matter was latterly coming away in the tank liquor (and lodging on the first contact bed) as to show that the tank should have been cleaned out at an earlier date than it actually was.

p. 10. Mr. Fowler states that determinations of this suspended matter made on different days gave numbers ranging from 4·9 to 11·6 grains per gallon, of which 55 per cent. was mineral matter. He apparently argues that, since no permanent decrease in capacity has been observed for a long time in the Roscoe filters, which receive chemically-precipitated effluent containing 1·35 to 4·0 grains suspended matter (60 per cent. of which is mineral), the same thing would hold here. But I think this would be better for further proof, because of the iron in the open septic tank effluent.

The length of life of the open septic tank, there fore, under ordinary conditions has still to be demonstrated.

Appendix C gives the results of the analysis of a sample of the Manchester tank sludge made by Mr. Frye. It contains, as might be expected, more sand than the sludge from filter-bed C.

2. Were the Filter-Beds, Especially the First Contact Beds, Being Choked up at all, and, if so, with what?

The presumption is, of course, against any appreciable choking, at any rate, of the second contact beds, judging from the excellent quality of the effluents. But it was thought well:—

(*a*) To make a direct test of the aëration of the beds (I should mention here that the idea of extracting the gases from a filter bed was originally due to Professor Ramsay).

(*b*) To examine the material of the filter-beds for sludge.

(*a*) *Aëration of the Filter-Beds.*

Appendix D gives the results of a direct test of this, *i.e.*, it gives the analyses of eight samples of gas drawn from the interior of several of the filter-beds. Without going into minute detail, these analyses show that the beds (excepting the first contact beds A and C, on December 5th, 1899), down to the depths given, were very fairly aerated, *i.e.*, oxygenated, on the dates mentioned. The most striking difference is between the first contact bed A on December 5th, 1899, and the same bed on January 3rd, 1900; on the latter date its aëration was very much better. Between those two dates, however, bed A had had a week's rest, which doubtless accounts for the improvement observed.

(*b*) *Examination of the Filter-beds for Sludge.*

In Appendix E are to be found the analyses of four samples of filter-bed material (three from first contact bed C and one from Cameron bed No. 3), and also analyses of the fine mud which that filtering material now contained. It will be seen that the greater part of this mud was at the top of the bed, but that it was gradually finding its way through. In connection with E, Appendix F should also be read, which gives data on the amount of iron and the state of that iron in the sewage, open and closed septic tank liquors, and first and second contact bed effluents. The points that strike one most here are:—

1. The large amount of iron in the Manchester Sewage.

2. The very large amount in the open septic tank liquor before the tank was cleaned out (and the same applies to the closed Cameron tank still).

3. The fact that as much as 1·5 parts of iron per 100,000 were latterly coming through the first contact bed, while almost none escaped through the second contact bed.

4. The fact that the iron in a sewage (*i.e.*, tank liquor) settles relatively more slowly than the other solids.

It is, therefore, evident that this part of the Manchester inquiry is not yet completely solved. It looks as if either more tank accommodation were necessary, or some rough and easily renewable filter between the tank and the filter beds proper, so as to prevent any appreciable amount of iron—and, with this, fine grit—passing on to the first contact bed. By one of these means the "life" of the first contact beds would undoubtedly be greatly prolonged.

In conclusion, it may be well to sum up shortly the main points of this criticism:

1. That the Manchester experiments, so far as they have gone, are most valuable.

2. That, from a chemical point of view, an excellent effluent is produced; and that the presence of the very large quantity of tarry matter has, so far, had no prejudicial effect upon this.

3. That it might be desirable to have some further data as to the first contact beds maintaining an average capacity of one-third of the empty tank capacity.

4. That the freeing of the tank liquor from suspended matter, and from all but a small quantity of iron, has not yet been accomplished to the extent which is desirable. When this is done the "life" of the first contact beds will be much lengthened.

I cannot conclude this without expressing my thanks to Sir Bosdin Leech, the Chairman of the Rivers Committee, and Mr. Fowler, who have been kind enough to give every facility to Mr. Frye and myself in the course of this inquiry. And my hearty thanks are due to Mr. Frye for his work in connection with it. Nearly all the analyses relating to the iron and sludge were done by him, and he has also made many valuable suggestions, the substance of which is given in these pages. I should also add that the analyses of the tank liquors and effluents (Appendices A and B) were made by Mr. R. B. Floris.

Ealing, July 10th, 1900. *George McGowan.*

APPENDIX A.

	Corresponding Samples Drawn Tuesday, December 5th, 1899.		Corresponding Samples Drawn Wednesday, January 3rd, 1900.			Mersey and Irwell Standard.
—	Effluent from 1st Contact Bed C. Analysed December 6th.	Effluent from 2nd Contact Bed D. Analysed December 6th.	Open Septic Tank Liquor, Analysed January 9th.*	Effluent from 1st Contact Bed C. Analysed January 8th.*	Effluent from 2nd Contact Bed D. Analysed January 9th.* *Analyses unavoidably delayed.	
Parts per 100,000.						
Ammoniacal Nitrogen	1·01	0·18	1·91	0·66	0·28	
Albuminoid „	0·20	0·08	0·74 (approx.)	0·15	0·05	0·12
Nitrite „	trace.	None.	None.	None.	None.	—
Nitrate „	0·42	1·40	—	0·58	0·67	—
Total Nitrogen by Kjeldahl	1·79	1·65	2·57	1·33	1·25	—
"X" Nitrogen	0·16	† None.	† None or 0·20	† None.	?	—
Total Organic Nitrogen	0·36	† 0·08	† 0·74 or 0·94	† 0·15	?	—
Oxygen absorbed at once	0·36	0·16	1·98	0·30	0·06	0·36
„ „ 4 hours	1·94	0·72	5·68	1·03	0·55	1·43
Oxygen absorbed after 5 days Incubation.	—	—	3·09	0·24	0·05	—
	Slight earthy smell after incubation.	No smell after incubation.	Tarry smell after incubation.	Slight tarry smell after incubation.	Earthy smell after incubation.	
Chlorine	13·18	13·14	10·02	9·96	9·86	
Remarks	Two hours' contact. Liquid almost colourless, with copious green-brown flocculent deposit. Slight tarry odour; alkaline.	One hour s contact. Almost no suspended matters. Slightly opalescent. Earthy odour. Nearly neutral.	Considerable black sediment. The filtered liquor was slightly yellow. Tarry smell; alkaline.	This sample had 2¼ instead of 2 hours' contact. Clean and tarry odour. Copious green-brown flocculent deposit. Slightly acid from carbonic acid.	Fairly average sample. Bed running all the time. Clean and colourless, like tap water; contained a few tiny worms. Slightly alkaline.	
GASES.						
Cubic centimetres per litre at N.T.P.	*Note.*—It will be observed that in every *Effluent* there is a reserve of Nitrate.					
Carbon dioxide (free)	55·0	40·7	—	53·9	42·2	—
‡Oxygen	1·0	2·6	—	0·9	1·4	—
Nitrogen	17·7	16·2	—	19·6	18·3	—

* This bottle had been mercury-jointed since 4th January.

† This is probably an error in the analysis; there would almost certainly be some "X" nitrogen present in the tank liquor and a little in the effluents. (G. M., May, 1902.)

‡ *Note.*—These figures for the oxygen must be a little higher than the reality, owing to slight aëration while transferring the effluents into the gas apparatus.

APPENDIX B.

Ammoniacal and Organic Nitrogen in Manchester Open Septic Tank Liquor, 1900.

Sample drawn	March 16	March 21	March 23	March 29	April 5	April 20	June 15
„ analysed	„ 19	„ 23	„ 26	„ 30	„ 21 (This sample was delayed in transit.)	„ 23	„ 18
Parts per 100,000:							
Ammoniacal nitrogen	2·64	2·30	2·81	2·51	3·20	2·38	2·91
Organic nitrogen	1·67	1·81	1·29	1·88	0·89	2·37	0·69
Total Nitrogen	4·31	4·11	4·10	4·39	4·09	4·75	3·60

All the above samples had a strong tarry smell, and the first six of them showed a considerable black deposit containing iron. Between the drawing of the sixth and seventh samples the tank was cleaned out, and the last sample had very little deposit.

APPENDIX C.

Analysis of Manchester Open Septic Tank Sludge.

This (average) sample was drawn when the tank was being cleaned out in May 1900, after fully fourteen months' use. At the inlet end the sludge was of a brownish colour, and very solid, but at the other end thin and quite black. It contained both animal and vegetable fibre, and smelt strongly of waste coal-tar products. The following figures were obtained :—

—	—	Calculated for the dry sludge.
	Per cent.	Per cent.
Moisture	81·00*	—
Matter volatile above 110° C.	6·98	36·7
Non-volatile matter, insoluble in hydrochloric acid	4·90	25·8 } = 45·1
Non-volatile matter (other than iron), soluble in hydrochloric acid	3·67	19·3 }
Iron (calculated as melallic iron)	3·00	15·8
Sulphur present as sulphate	Trace.	Trace.
Sulphur present as sulphide	0·45	2·4
	100·0	100·0

* *Note.*—The iron was, of course, not present as metallic iron, but as sulphide and hydroxide. Hence the figure given for either the moisture or volatile matter is not absolutely correct.

APPENDIX D.

ANALYSES of GASES drawn from the interior of the Manchester Filter Beds.

Samples 1, 2, 3, and 4 were drawn on 5th December, 1899 ; 5, 6, 7 and 8 on 3rd January, 1900.

—	Atmospheric Air.	No. 1. From 1st Contact Bed A, about middle of Bed, and at a depth of 2 feet. Bed had rested 3¼ hours (usual rest is 3 hours).	No. 2. From 1st Contact Bed C, about middle of Bed, and at a depth of 2 feet. Bed had rested 50 minutes (usual rest is 1 hour).	No. 7. From 1st Contact Bed A. From upper end of Bed and about half way across it, at a depth of 2 feet. Bed had rested 3 hours (the usual time before refilling).	No 8. From 1st Contact Bed A. From lower end of Bed and about half way across it, at a depth of 2 feet. Bed had rested 3¼ (instead of 3 hours).	No. 4. From 2nd Contact Bed. From middle of Bed, at a depth of 2 feet. Bed had rested 1 hour (the usual time)	No. 5. From 2nd Contact Bed D. About 1-3rd down the Bed and 2-3rds across it, at a depth of 1 foot 4 inches approximately. Bed was still running. It was about to be refilled.	No. 6. From 2nd Contact Bed D. Near lower end of Bed and about half way across it, at a depth of 1 foot 4 inches approximately. Bed running as above.	No. 3 From Roscoe Bed (cinder). From about middle of Bed at a depth of 2½ feet. Bed had rested 3 hours (2 hours is the usual time).
By Volume.									
Carbon Dioxide	0·04	4·4	5·8	2·3	3·5	4·0	3·1	3·2	4·6
Oxygen - -	20·95	**10·8**	**12·0**	**18·9**	**15·9**	**17·6**	**16·0**	**14·8**	**14·5**
Nitrogen - -	79·01	84·8	82·2	78·8	80·6	78·4	80·9	82·0	80·9
Methane	–	None	–	Not tested for, since none was found in No 1.				–	–
	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

APPENDIX E.

STATE OF THE MANCHESTER FILTER BEDS AS REGARDS SLUDGE.

The bed which has been mainly examined is the *First Contact Bed C.* This, it will be remembered, dates from April 13th, 1899.

—	Bed C. (1). Sample drawn by Mr. Fowler 3 inches below surface, about middle of bed, on March 21st, 1900. The bed had been run off for four hours.	Bed C. (2). Sample drawn under same conditions as (1), but 1 foot below surface.	Bed C. (3). Sample drawn by Mr. Frye on April 20th, 4 inches from the bottom. The bed had been resting for a week. *This had a sewage smell.*	Cameron Bed No. 3. (4). An average sample drawn by Mr. Frye on April 20th. This smelt of Nitro-benzene.
Moisture - - - -	28·20	27·20	37·30	41·00
*Fine Mud - - -	10·05 (by dif.)	4·40 (directly)	3·30 (directly)	3·33 (directly)
Clinker and coarse Sand	61·70	68·32	58·81	55·65
Sulphur as Sulphide -	Trace.	Trace.	Trace.	—
Total Sulphur - -	0·05	0·08	0·09	0·02
	100·0	100·0	100·0	100·0

* *Analysis of the above dried muds.*—These muds were obtained by gently and repeatedly stirring up the clinker with small quantities of water in a mortar, until the liquid ran off clear, or nearly so.

					Tank Sludge.
Volatile matter - -	45·10	45·40	45·20	44·50	40·6
†Iron, calculated as Sesquioxide - - -	24·71	24·20	18·80	23·40	22·60
Sand, etc. (by dif.) - -	30·19	30·40	36·00	32·10	36·80
	100·0	100·0	100·0	100·0	100·0

† Ten parts of sesquioxide of iron are equivalent to 7 of metallic iron. The iron was no doubt present for the most parts in a less oxidized from than the sesquioxide ; the amounts of "sand, etc." as given above, are therefore below their true value.

APPENDIX F.

IRON in the MANCHESTER SEWAGE, Open Septic Tank liquor and Filter-bed effluents at different dates.

SERIES I.

OPEN SEPTIC TANK LIQUOR.

Parts per 100,000.	1900. March 23.	March 21 and 29 (mixed).	June 15.
Fine Grit	4·0	2·82	1·21
Iron in colloïdal and true solution, given as metallic iron	1·33	6·58	1·64
Iron in suspension	5·81		

Notes.—1. The "iron" also includes any alumina present.

2. Between March 29th and June 15th the tank had been cleaned out, and the difference in the figures for iron is at once apparent. The difference in the appearance of the samples was equally marked; the earlier ones contained much black iron sediment, whereas in the sample of June 15th there was hardly any.

SERIES 2, 3, AND 4.

When the samples of Series 2 were drawn by Mr. Frye, the open tank was being cleaned out. Hence a sample of liquor from the *closed* Cameron tank was taken instead.

The "iron" in these series does *not* include any alumina present.

Parts per 100,000.	Sewage.	Open tank.	Closed Cameron tank.	Effluent from Bed C.	Effluent from Bed D.
(2.) 9th May.					
Iron in suspension	0·56	—	4·16	0·40	0·12
Iron in colloïdal and true solution	0·34	—	0·84	Trace	Faint trace.
	0·90	—	5·00	0·40	0·12
The open septic tank had now been re-started for 3½ weeks, but it was not yet properly septic.					
(3.) 11th June.					
Iron in suspension	13·42	0·68	2·44	0·46	0·05
Iron in colloïdal solution	0·46	0·46	0·76	Trace	Trace
Iron in true solution	0·12	0·06			
	14 00	1·20	3·20	0·46	0·05
There had obviously just been a heavy flush of iron liquor into the sewage.					
(4.) 15th June.					
Iron in suspension	2·54	0·46	9·20	1·32	0·10
Iron in colloïdal solution	0·26	0·81	0.80	0·12	—
Iron in true solution	Trace	0·03	Trace	—	—
	2·80	1·30	10·00	1·44	0·10

There had been rain just before these last samples (Series 4) were drawn, and the sewage was at nearly twice its normal flow. For this reason the iron in the sewage is probably only half what it would have been normally. The other samples are not affected by this.

SERIES 5.

(a). *Manchester Sewage. Average sample of six days*, taken every hour from June 11th, 1900, 9 a.m., to June 17th, 6 a.m.

(b). *Open Tank Liquor. Average sample of six days*, taken exactly like the sewage above. [N.B.—The tank was not yet properly septic.]

(c). *Average sample* of all the emptyings from *First Contact Bed C* on June 14th, 15th and 16th (*i.e.*, throughout three days). Samples were in this case taken every five minutes while the bed was being emptied.

(d). *Average sample* of all the emptyings from *Second Contact Bed D*, taken for three days in exactly the same way.

Parts per 100,000.	Sewage.		Open Tank Liquor.		Effluent from Bed C.		Effluent from Bed D.	
	Grav.	Vol.	Grav.	Vol.	Grav.	Vol.	Grav.	Vol.
Total Iron	8·76	5·20	1·54	1·14	1·51	1·08	0·24	0·06
Solids in Suspension	61·5		7·52		3·20		2·50	
Solids in Solution	75·5		76·88		77·20		79·92	

NOTES.—1. These average samples were taken in equal quantities, not according to rate of flow; but the results given by Mr. Fowler in Annual Report for the year ending March 27th, 1901, p. 33, show that the difference between the samples taken in this way and others taken according to the rate of flow is not very striking, at any rate in dry weather (May, 1902).

2. The volumetric estimation gives the iron proper. The difference between the gravimetric and volumetric gives the alumina, calculated as iron.

3. When the samples from Beds C and D were taken, the beds had only been working for a week, since resting for a fortnight, and one foot of material had been removed from Bed D during the rest. The depth of material in D was therefore two feet.

4. The amount of iron in the Manchester sewage is much greater than we had supposed.

The mud (under the microscope) was seen to be composed of very small particles. It contained some fibre, but not anything like so much as Mr. Frye finds in the mud of the Leeds beds, which are treating crude sewage there. The chief differences between the Manchester and Leeds filter-bed muds are:—

MANCHESTER.	LEEDS.
Chocolate brown.	Reddish brown.
Finely divided.	Pulpy.
Slightly fibrous.	Very fibrous.

Further, on drying, the Leeds mud shrank considerably, and could be shaken off the coke, whereas the Manchester mud adhered to the clinker so strongly that it could only be got off by boiling water and rubbing. The Manchester sludge was the more easily washed off when wet.

It will be seen from the above figures that the percentages both of fine black mud and of iron got less, the deeper down in the bed the samples were drawn. At the bottom of the bed C, on April 20th, the clinker smelt very badly. This, I think, shows that the bed was not in a satisfactory condition at that date, although it had rested for a week. The upper samples had only an earthy smell.

All the above "muds" agree very nearly in composition, and, as Mr. Frye has already pointed out, this looks as if the organic matter of the mud was broken down nearly as far as it could be under actual working conditions. The same thing is noticeable in the muds from the Leeds beds, *i.e.*, they agree in composition among each other, but in these the percentage of volatile matter is higher than in the Manchester samples (about 55 per cent. as against 45 per cent.). Another point of interest is that the Leeds Whittaker bed mud contained far more sulphide than the Manchester samples; Mr. Frye finds that, the greater the amount of sulphide, the more clogged this particular bed appears to be.

A short examination of the foregoing figures in this appendix shows:—

1. The very large quantity of iron that was being brought over by the tank liquor on to the first contact bed, before the tank was cleaned out.

2. The larger quantity of fine grit that was also being carried over under these circumstances.

3. That the liquor from the closed Cameron tank is also delivering much suspended iron, and requires to be cleaned out. Besides the iron in suspension, there is also more iron in solution in the closed tank liquor than in the sewage.

4. That the average six days' sample of sewage is very heavy both in iron and suspended matter.

5. That when one compares the open tank liquor (six days' sample) with the sewage (six days' sample), the decrease in the iron is from 100 to 17·6 Grav. or to 21·9 Vol.,* while the decrease in suspended solids is from 100 to 12·2.

The iron therefore does not deposit so rapidly as the other solids. Mr. Frye has found exactly the same thing at Leeds.

6. That the two filter-beds C and D remove practically all the iron that is in solution in the liquid going on to them; and, by the time the final effluent has left the second contact bed, something over 90 per cent. of the total iron of the sewage has been removed (by tank and beds together). Further, the iron that is left in the effluent is practically all in suspension. This result in quite in agreement with those which Mr. Frye has obtained in the same manner from the contact beds at Leeds.

George McGowan.

Ealing, London, W.
July, 1900.

* *Note.*—The gravimetric estimation gives oxide of iron, alumina and alkaline earth phosphates together, while the volumetric gives iron alone.

PROVISIONAL NOTE ON THE BACTERIOLOGICAL QUALITIES OF CRUDE SEWAGE AND SEWAGE EFFLUENTS AND THE QUESTION OF STANDARDS IN RELATION TO POTABLE AND NON-POTABLE STREAMS.

Dr. Houston.

THE BACTERIOLOGY OF CRUDE SEWAGE.

Total Numbers.

Crude sewage usually contains at least one million bacteria per cc., and not uncommonly more than ten million. Of these a large proportion are capable of growing in the laboratory at blood heat.

But as this proportion of the several sorts of sewage microbes which together go to make up the total number of bacteria in a sample does not necessarily remain constant throughout the complex changes leading to the ultimate purification of the sewage, only a limited amount of reliance can be placed on estimation of total numbers. For example, different processes of sewage disposal, all yielding fairly comparable results as regards the total number of bacteria in their respective effluents, may yet differ one from another in marked fashion in respect of the sorts or kinds of bacteria (and their relative abundance) which together went to make up the total number in each of the several effluents.

B. Coli.

The number of B. Coli (or closely allied forms) in crude sewage is apt to be at least 100,000 per cc. B. Coli is an intestinal bacterium, which may be pathogenic, and certainly its presence serves as an index of the probable presence of other and perhaps more objectionable bacteria of excremental sort. Hence enumeration of B. Coli in crude sewage and effluents may be considered highly important. If B. Coli is present habitually in from $\frac{1}{10,000}$ to $\frac{1}{100,000}$ of a cc. of raw sewage, and is absent, as has been alleged, in the bacteriological contents of as much, it may be, as 10 to 100 cc. of a pure water, this biological test is one of extreme delicacy. In connection with this test, as also with others, it is important to determine the number of such organisms per cc. A mere statement of their presence or absence is of little value.

Apart from the proof of its direct association with human ailments, any microbe pathogenic to the lower animals must be regarded with some suspicion as a possible cause of harm also to the human subject. But the more highly specialised forms of the Coli group would seem to be connected—in some cases obscurely, in others in more certain fashion—with the occurrence of definite morbid processes in man.

In brief, this B. Coli test must be regarded as of great importance: in the first place, because the presence of B. Coli serves as an index of the possible presence in the medium yielding it of other and more objectionable microbes; secondly, because certain strains of B. coli are distinctly pathogenic in the case of lower animals; and last, but not least because there is ground for considering that B. Coli may play a rôle in the causation of human diseases.

B. Enteritidis Sporogenes (Klein).

The number of spores of B. Enteritidis Sporogenes in crude sewage is usually at least 100 per cc. Avoiding matters which may be open to controversy, it is at the least certain that cultures of B. Enteritidis Sporogenes may be, and often are, extremely virulent to guinea-pigs. Further, there is evidence, according to Dr. Klein, that B. Enteritidis Sporogenes has been casually related to certain epidemics of acute diarrhœa in the human subject.

This B. Enteritidis Sporogenes test is one of easy application, and gives some indication of the total number of spores of anaerobic bacteria of all sorts present in the substance under examination. The B. Coli test is performed under aerobic conditions, and the B. Enteritidis under anaerobic conditions. *It seems most important to have an anaerobic as well as an aerobic test, and for this reason alone the continued use as a routine measure of the B. Enteritidis test is desirable.* The fact of its being a sporing anaerobe weakens somewhat the usefulness of the test as an indication of recent contamination in connection with the bacteriological examination of potable waters. But such an objection, for manifest reasons, does not apply to sewage effluents.

Incidentally it is of interest to note that the spores of B. Enteritidis are absent from as much as 100-500 cc. of a pure water, are present only in sparse numbers in virgin soils, but are present in great abundance in soils polluted with matters of excremental sort.

Streptococci.

The number of streptococci in crude sewage would seem to be at least 1,000 per cc.

Speaking of streptococci as a class, without special reference for the moment to sewage streptococci, it would appear that:—

They are delicate micro-organisms, and readily lose their vitality and die.

They probably are little prone to enter on a saprophytic phase or to multiply to any great extent, if at all, under such conditions.

They are present in the intestinal discharge of animals.

They comprise micro-organisms of highly pathogenic sort.

They are seemingly absent from relatively large amounts of pure waters and from virgin soils, but can be readily demonstrated in soils and waters recently polluted with excremental matters.

Assuming the foregoing to be even approximately true, this streptococcus test is an important one. For example, if the streptococci met with in sewage are of intestinal origin, and are of feeble vitality, their presence in any number in an effluent would lead to the inference that the "biological treatment" processes at work and responsible, as it were, for the production of such an effluent were not strongly inimical to the vitality of other and more hardy germs likewise of intestinal outcome. And in the latter category we would presumably be forced to include both the typhoid bacillus and the cholera vibrio. Quite the same could not be claimed for the Coli test already referred to since B. Coli is a more hardy germ than B. typhosus or the cholera vibrio. And it is worthy of note that this streptococcus test could be applied with confidence to any effluent from any system of sewage disposal, whereas search for B. typhosus in sewage and sewage effluents must be regarded as an almost hopeless task, and the failure to demonstrate its presence no indication whatever of its real absence. Recently, however, Dr. MacConkey has carried out an elaborate research, having for its main object the discovery of a simple and reliable method of isolating the typhoid bacillus from a liquid containing a mixed bacterial flora. Such a method would be of great value.

The pathogenicity of sewage streptococci does not appear to have been established, but it is well known that virulent streptococci rapidly lose their pathogenic action when separated from the animal body and cultivated on artificial media. Moreover, the failure to induce a pathogenic effect by the micro-organisms in the lower animals affords no sufficient criterion that the streptococci in question are harmless to man.

But putting aside the question of pathogenicity, the test in its positive aspects must be regarded as an index of no mean value of the probable biological quality of a sewage effluent in relation to the possible spread of disease.

Gas Test for Indicating Presence of B. Coli, B. Proteus, and other Gas-forming Bacteria.

The aerobic (or facultative anaerobic) gas-forming bacteria in sewage belong chiefly to the objectionable Coli and Proteus class, and a simple method of arriving at a rough estimation of the abundance of these microbes has been worked out. For example, $\frac{1}{1,000}$ cc. of crude sewage usually produces "gas" in gelatine shake culture in 24 hours at 20°C., while the bacterial contents of as much it may be as 100cc. of a pure water fail to effect a similar result.

This represents a remarkable biological distinction between raw sewage and pure water; and if, as seems likely, it can be shown that at any point between these two extremes the number of gas-forming bacteria affords a reliable index of the status of a liquid in respect of the degree of purification effected and its relative harmlessness, the test is a valuable one. Indeed, if there exists a parallelism between the number of gas-forming bacteria and the putrescibility and harmfulness of effluents, it might even be claimed that this test is of singular importance.

It would seem that no liquid containing these gas-forming bacteria in a minimal quantity can be considered free from the putrescible organic matter which maintains their existence. Theoretically this may be true, but practically the reduction of the putrescible organic matter might in some cases be so rapid as perhaps not to allow of a corresponding reduction in the number of these microbes.

Inoculation.

The injection subcutaneously of crude sewage even in moderate quantity into rodent animals, is always followed by a local reaction, and not uncommonly leads to a fatal result. Certain microbes isolated from the blood or tissues of such affected animal appear to be highly virulent. How far this is due to an exaltation of virulence of sewage bacteria due to their passage through the animal, and how far it is a virulence proper, as it were, to the microbes previous to the inoculation, may be hard to determine. And it seems doubtful if these peccant microbes could readily be recognised in cultivations made directly from the sewage without resorting to the inoculation of animals. Nevertheless, it is of considerable interest to learn that even small quantities of crude sewage habitually contain germs of a sort virulent to rodents. As a routine test, however, the inoculation of animals could hardly be recommended.

Other Tests.*

The enumeration of thermophilic bacteria, liquefying microbes, spores of aerobic bacteria, etc., although doubtless yielding results of considerable value, would seem to be of secondary importance to the tests already considered.

In summary at this stage we note that crude sewage usually contains at least in 1 cc.:—

1-10 million bacteria.

100,000 B. Coli (or closely allied forms).

100 spores of B. Enteritidis Sporogenes.

1,000 streptococci.

Further, that so minute a quantity as $\frac{1}{1,000}$ of a cc. of crude sewage is usually sufficient to produce "gas" in gelatine shake cultures in 24 hours at 20°C., and that the inoculation of animals with crude sewage always lead to a local reaction, and not uncommonly results in death.

THE BACTERIOLOGY OF SEWAGE EFFLUENTS.

A large amount of information has been gained under this heading. The general outcome of the experiments may be summed up as follows:—

Effluents from Artificial Processes.

The effluents from septic tanks, intermittent contact beds, continuous filtration beds, etc., contain an enormous number of bacteria. In some cases the percentage reduction of microbes in effluent as compared with raw sewage is striking. But as an effluent must be judged by the actual state it is in, and as the number of micro-organisms still remaining is nearly always very large, percentage purification would seem to be of minor importance. In not a few cases the bacteria are practically as numerous in the effluent as in the raw sewage.

The different kinds of bacteria and their relative abundance appear to be very much the same in the effluents as in the crude sewage.† Thus, as regards undesirable bacteria, the effluents frequently contain nearly as many B. Coli, proteus-like germs, spores of B. Enteritidis Sporogenes and streptococci, as crude sewage. In no case, seemingly, has the reduction of these objectionable bacteria been so marked as to be very material from the point of view of the epidemiologist. No definite proof has been furnished that the effluents from bacteria beds are conspicuously more safe in this sense in their possible relation to disease than is crude sewage. Indeed, all the available evidence tends to show that they must be regarded as nearly, if not quite, as dangerous to health as raw sewage. In this connection we would again take note of the streptococcus test. If it be true that streptococci are more delicate germs than the typhoid bacillus, their presence in any number in the effluent would seem to indicate the possibility or probability of the enteric fever bacillus also surviving under similar conditions, and, in general, would lead us to infer that the biological processes at work were not strongly inimical, if hostile at all, to the vitality of germs of pathogenic sort.

The inoculation of animals with the effluents from bacterial beds seems to show that they are nearly as pathogenic as crude sewage.

In conclusion, and speaking in general terms, it is to be inferred that the effluents from bacteria beds are bacteriologically so impure that they may well be excluded from streams that are used for drinking purposes. Need for this inference is the more to be regretted since the same effluents often pass a reasonable chemical standard. Presumably the bacteria-bed-process is so rapid that the decline in the amount of oxidisable and putrescible matter in the sewage passing through is not accompanied by a corresponding reduction in the number of bacteria; and commonly the units of material composing the bed are of so large a size as to preclude the possibility of the mere mechanical separation of the germs.

Effluents from Land Treatment.

Much work has been carried out as regards the bacteriological examination of land effluents, and the work is sufficiently advanced to call for a complete report within the next few months. In the meantime, some remarks on this subject of a provisional and general character seem advisable.

It would appear to be possible with land of proper quality, and, by intelligent management, to obtain remarkably good bacteriological results; in some, although rare, cases, results so good that, apart from a knowledge of its source, the effluent might actually be regarded as a potable water of more than average purity. Generally speaking, however, the effluents from land, like those from bacterial beds, are not to be thought of as in a fit state to be turned into a potable stream. Unfortunately also, the ratios one to another of the different sewage microbes tend to remain fairly constant, no matter how great the purification may be. The bacteria proper, peculiar, as it were, to the soil, are seemingly either absent or present in small proportion only in these land effluents. Yet the sewage bacteria do not seem to destroy the soil microbes; for examination of the soil itself shows that the latter are present in abundance. On the other hand, when the soil is "rested," some, at all events, of the sewage bacteria disappear. A broad parallelism would seem to exist between the chemical and bacteriological results obtained by land treatment of sewage. We may reasonably consider that this is due to the comparative slowness of the process allowing the bacteria in the sewage to decline in numbers side by side with the reduction in the amount of oxidisable and putrescible matter; and in this respect land treatment would seem preferable to artificial filters. At the same time, it must be remembered that the diminution in the number of bacteria by land treatment must also be traced to their mechanical separation. The effluents from land usually contain B. Coli, spores of B. Enteritidis Sporogenes, and even streptococci.

In conclusion, the treatment of sewage on land, although perhaps more satisfactory from the bacteriological point of view than its treatment in bacterial beds, would not seem to by any means entirely remove the danger arising from the discharge of effluents into potable rivers.

In general summary it is to be noted that the effluents alike from land and from bacteria beds contain B. Coli, B. Enteritidis Sporogenes, and Streptococci often in

* Since writing this report (Feb., 1901) other tests have sprung into prominence, notably, Dr. MacConkey's useful bile-salt broth test. These will be dealt with in a separate report.

† That, however, some selective process is really in operation need hardly be doubted, although it might require special media and special processes to prove it.

abundance, and that, therefore, they are not so modified bacteriologically as to allow of their safe introduction into potable rivers.

EFFLUENTS FROM CHEMICAL PROCESSES.

It may be seriously questioned whether we have sufficient knowledge as to the effect of the chemical treatment of sewage as regards the biological composition of the resulting effluents. We gather that chemical treatment of a sewage does not prevent further treatment of it in bacteria beds and on land, and in general does not destroy the sewage bacteria. But our knowledge is deficient in this respect, and much work must be carried out before conclusions of any value can be drawn. It is an important matter, because it might, for instance, be affirmed that a particular process—say a combined chemical and land, or a combined chemical and bacteria bed method—was satisfactory, because the chemicals first destroyed the pathogenic germs, while the land or bacterial beds afterwards purified the sewage, so that the final effluent was quite innocuous.

In this connection the streptococcus and B. Coli tests would seem, the former in its positive aspects, the latter in a negative sense, to be of value. For, assuming it to be true that streptococci are less and B. Coli more hardy than such pathogenic germs as B. typhosus and the cholera vibrio, the presence of streptococci would seem to imply the possible presence as well of disease germs, while the absence of B. Coli would suggest comparative safety?

THE CHEMICAL AND BACTERIOLOGICAL EXAMINATION OF EFFLUENTS, AND THE QUESTION OF STANDARDS IN RELATION TO DRINKING AND NON-DRINKING STREAMS.

It seems quite clear that a chemical examination of effluents will be required in the case of both potable and non-potable rivers. In both cases it is necessary to prevent the discharge into the river of an undue amount of oxidisable and putrescible matter. Even if an effluent were sterilised, a chemical examination would still be required to show that it contained no organic substance susceptible to the action of putrefactive bacteria present in the water of the river. Cases have occurred where an effluent rich in putrescible matter has been actually sterilised but which nevertheless produced a filthy nuisance in the river some distance below the point of discharge. The time is past to usefully discuss whether it is better to have a sterile effluent rich in organic matter, or a non-sterile effluent free, or nearly so, from putrescible matter. All effluents, whether sterile or non-sterile, must be relatively free from all substances susceptible to the action of putrefactive bacteria. Further, at all events in the case of drinking water streams, it is necessary for the chemist to say whether the effluent is free from chemical poisons in dangerous amount.

DRINKING WATER STREAMS.

Passing next to the more difficult subject of bacteriological standards, a bacteriological standard in the case of drinking water streams is certainly called for, and, indeed, is far more important than the chemical one. Yet, for the reasons above stated, a chemical standard must be retained as well.

Organic matter *per se* in water is seemingly harmless; it is the bacteria likely to be associated with the organic matter that constitute the element of danger. Only bacterioscopic analysis can hope to reveal the kinds of bacteria in an effluent which are of a sort liable to be related to disease. Chemistry is quite powerless in this respect, and, indeed, all chemical standards of potability are apparently based on an assumed relationship, which may or may not exist, between the amount of organic matter and the number and kinds of the associated bacteria. Typhoid fever stools, whether sterilised and innocuous, or unsterilised and highly dangerous, would yield to chemical testing practically the same results as regards the nature and amount of organic matter present.

Nevertheless, it may be doubted whether bacteriologists in general have fully met their responsibilities in this connection. For while it may be recognised that the burden of showing that an effluent is harmful or harmless (in the case of potable streams) ought to rest in their hands, the present state of bacteriological knowledge may not allow of their accepting the responsibility. It is one thing to believe in the principle of a bacteriological standard, and quite another thing to produce a standard which is altogether satisfactory.

But within recent years bacteriology has made great strides, and in directions tending to advance knowledge in this matter. For example, it would seem that bacteriologists have passed through a stage of mere enumeration of total numbers of micro organisms to a stage taking note of particular microbes; and from this have reached the stage of seeking to determine the relative abundance of these particular microbes in one or another substance. One result of these labours has been to show that a remarkable distinction can be drawn between pure water and a foul liquid like sewage, and that a water containing an amount of sewage so minute as to be beyond the reach of chemical analysis can yet be shown bacteriologically to be rich in intestinal microbes. A single instance will suffice: B. Coli is absent from as much it may be as 100cc. of a pure water, and yet is habitually present in from 1-10,000 to 1-100,000 of a cc. of crude sewage. On the plea of mere ability to recognise the presence and relative abundance of such intestinal microbes as may be considered to serve as in index of the possible presence as well of the bacteria of epidemic disease, the bacteriologist might reasonably claim that his delicate processes were in advance of the chemist. And this perhaps is as far as we may hope to get. For at present, when dealing with non-sterile effluents, the bacteriologist has no infallible test enabling him to say—this effluent does not contain the specific germs of epidemic disease. And we know that when these pathogenic germs are really present they may readily escape recognition.

But it would be unwise to regard sewage otherwise than as a liquid always potentially dangerous, and much is now known about its biological composition and the relative abundance of those intestinal germs apt to be associated with the pathogenic microbes which by their occasional or constant presence may render the liquid actually dangerous. By so much then as an effluent is modified in greater or less degree in the direction of departure from our normal sewage standard as regards these "germs of indication," to an equal extent are we privileged in measuring its status in respect of possible danger to health. In this sense bacteriologists have made real progress, and from this point of view standards may be of singular value.

The "microbes of indication" as has been already indicated would seem to be B. Coli, streptococci, and B. Enteritidis Sporogenes. These bacteria are wholly, or at all events relatively, absent from pure water; but there can be little doubt that some drinking waters do contain these objectionable microbes, although in insignificant proportion as compared with sewage and sewage effluents. Doubtless these waters are slightly polluted; but the fact of the presence in the water of these bacteria, and that they are used for potable purposes must not be lost sight of. Although on scientific grounds the complete removal or destruction of these bacteria is strongly indicated, it may be doubted if this counsel of perfection is wholly defensible in practice.

At this point it may be useful to consider ways and means of rendering a potentially dangerous effluent actually or relatively innocuous. Filtration might perhaps be employed to greatly and perhaps sufficiently reduce the number of bacteria present in an effluent. But it is open to doubt if the cost could be borne of first purifying sewage so as to get rid of most of the organic matter and the bulk of the suspended matter, and afterwards to subject the effluent to an efficient process of filtration. Presumably it would cost as much to satisfactorily filter the sewage effluent of a town as it would cost to filter the water supply of the same town.

Next as regards the complete or partial sterilisation of the effluents by chemical substances. By complete sterilisation is meant the absolute destruction of all microbes, sporing and non-sporing. By partial sterilisation the death of all bacteria present as bacilli (or in coccus form) is implied, but not the death of the spores of bacteria. And for a reason presently to be explained it is of advantage to limit this a little further by saying that this partial sterilisation may be judged to be sufficient if B. Coli is destroyed.

This distinction is important, because the difficulty of killing spores is very great, whereas bacilli (and cocci) are much more easily destroyed. Thus the thermal death point of B. Coli is about 60-65° C.; of some spores actually 120° C. And the same striking difference holds good in the main as regards chemical antiseptic substances. It is evident then that the difference in cost between the complete and partial

sterilisation of an effluent would be a very material difference, and it may be questioned if the additional freedom from danger resulting from complete sterilisation would merit the extra expenditure.

The number of spores of aerobic and anaerobic bacteria in sewage would seem to be about 100-1,000 per cc. in the case of a total bacterial flora of 1-10 million or more. So that the spores form a relatively small proportion of the total germs in sewage. Of pathogenic spores habitually or occasionally present in sewage B. Enteritidis Sporogenes, tetanus, malignant œdema and anthrax must be considered. Are we to consider that the risk of these and other sewage spores remaining in an effluent which is being discharged into a potable river is so grave that complete sterilisation is absolutely necessary? In the present state of knowledge this can hardly be said, and having regard to the almost insuperable difficulties attending complete sterilisation of effluents, to insist upon it would seem to be impracticable.

What then would the partial sterilisation of effluents mean? It seems justifiable to conclude that the destruction of B. Coli would mean the death of the typhoid bacillus, and perhaps in general of the germs of epidemic disease. And it may be seriously questioned if the practical difficulties and the cost of such partial sterilisation is in any way out of proportion to the enormous gain in securing comparative immunity from danger. A large number of substances would seem to be capable of effecting this object at a reasonable cost, *e.g.*, ozone and chlorine compounds.

The question what means are available for sterilising or partially sterilising sewage effluents, and what would be the cost of adopting such means, is one which should, I think, be definitely settled by further experiments.

In the present state of knowledge, and bearing in mind what is practicable, I consider that in the case of potable rivers it would be reasonable to require that an effluent be free, or nearly so, from putrescible matter as judged by chemical standards; and be free also from the specific germs of epidemic disease, *e.g.*, B. typhosus as judged indirectly but seemingly in safe fashion by the absence of B. Coli. It might be convenient to fix some limit, *e.g.*, that B. Coli must be absent from 1 cc. of a sewage effluent that if this end could be attained by filtration or other method not to consider the use of chemical substances essential. Nevertheless even sand filtration could not render an effluent innocuous in the same way as sterilisation. Such a standard as that suggested has the advantage of extreme simplicity, and it would take no note of the relative volumes of the effluent and river water, a matter which if taken into consideration greatly complicates the question of standards.

Non-Drinking Water Streams.

As regards non-drinking water streams the question of bacteriological standards is also a difficult one.

We must consider in the first place the possibility of the discharge of a bacterially impure effluent into non-drinking water streams being a means of spreading disease.

All streams which are not brackish or obviously offensive to taste or smell, or which do not present strongly to the eye the appearance of pollution, are liable to be used as sources of drinking water occasionally or even habitually by some individuals.

Bathing is commonly indulged in in non-drinking water streams. Whatever may be said of its comparative harmlessness, numerous cases of sickness and diarrhœa have been referred to this cause. And it would of course be quite possible for typhoid fever and cholera to be spread in this way.

Further, there is always the possibility of the water of non-drinking water streams being brought into relation with articles of food or drink. For example, the reprehensible practice of rinsing milk cans in water of this class may specially be cited. Again, watercress is frequently grown in sewage-polluted water.

It has been asserted that there is danger in eating fish caught in sewage-polluted streams. But any danger that might be supposed to exist should be removed by cleaning and cooking the fish. In the case of oysters and other shell-fish (tidal waters), when eaten in the raw condition the risk, however, may be a very real one.

There would also seem to be some danger of wells in the vicinity of polluted streams becoming contaminated. Soil is a very perfect filter under ordinary conditions, but sometimes fissures exist which may allow sewage matters to travel for a considerable distance in a practically unaltered condition. Moreover, soil may in course of time become so polluted as to be saturated with germs, and in such cases the microbes tend more and more to spread beyond their original limits. Lastly, floods may carry sewage-polluted water over the surface of adjoining land and so contaminate wells.

Some authorities consider that cattle suffer from drinking the water of sewage-polluted streams. But of this there is no very definite proof.*

Then there is the question of flood water depositing suspended matter and innumerable bacteria on the river banks. These in the dry condition may be carried by the wind for a considerable distance.

The possibility of danger to health from the inhalation of noxious gases is a separate question, and will not be considered here.

These factors, considered separately, may be of no great importance; taken together they cannot, as it seems to me, be entirely ignored.

A broad view of the case would seem to be that the danger is not abundant or far-reaching; that it tends to affect individuals rather than large communities. And although a single case of typhoid fever may, if circumstances favour it, create a widespread epidemic, too much stress should not be laid on concrete instances, but reliance placed rather on general considerations.

After careful consideration, I should be inclined to say that in the case of non-drinking streams—*except where oysters and other shell-fish which are eaten raw are concerned*—the bacteriological character of an effluent is of secondary importance.† But even from this secondary point of view the bacteriological examination may be of considerable utility for ascertaining the actual or potential putrescibility of an effluent.

Critics will be ready to note one circumstance; namely, that bacteriologists seem unable to say exactly the kind of microbes which, by their presence or relative abundance in an effluent, prove the presence of unfermented organic pabulum, and which therefore are to be thought of as peculiarly associated with the production of offensive putrefactive processes. All microbes are, however, in a sense putrefactive, and even pure water contains microbes which, in the presence of unconverted organic matter, can give rise to a putrescent effect. Recently some little progress has been made in this direction. Sewage, our standard liquid in the foul sense, contains gas-forming bacteria of the objectionable Coli and Proteus class in great abundance. Potable water, our standard in the pure sense, does not contain these microbes or contains them in small proportion only. Between these two extremes, and at any point between them, the number of gas-forming bacteria would seem to be a not unsatisfactory index of the amount of putrescible matter still remaining in the liquid. In other words, side by side with the destruction of the substance or substances which render sewage an offensive liquid there is a corresponding decline in the number of these gas-forming bacteria. If this were absolutely true, the estimation of the number of gas-forming bacteria would be of singular importance. Unfortunately, it is only approximately true, and the reasons are fairly obvious. As already said, in bacteria beds the process is so rapid that we may get a speedy destruction of the putrescible matter without a corresponding decline in the number of putrefactive bacteria, while the size of the fragments of coke or other substance composing the bed is commonly such as to preclude the possibility of the mere mechanical separation of the germs in question. In land treatment, on the other hand, the process is in comparison slow, and the destruction of the organic matter and the decline in the number of these bacteria to a corresponding extent

* † It may, however, be mentioned that in my examination of the process of septic tank followed by contact beds at Yeovil, I have found anthrax in large numbers, not only in the tank itself, but also in the coarse and fine beds. This examination was made some five months after the works had ceased to be used, and I could not therefore examine the final effluent, although the inference would seem to be that anthrax spores must have been present occasionally, if not habitually, in the final effluent. The question of the extent of danger to cattle in consequence of the presence of anthrax in streams from which they drink is not one easily answered. But it seems to me obviously desirable to exclude anthrax from such streams if this be practicable

may go hand in hand. But sometimes we seem to get a mechanical separation without a corresponding destruction of the putrescible organic matter in solution. Thus, of two effluents, the one from a bacteria bed process, the other from land—both containing a very similar amount of organic matter—the former might contain numerous gas-forming bacteria, and the latter relatively few. In this connection it is worthy of note that the rapidity of the bacteria bed processes, although of great practical value, is from the epidemiological point of view a positive disadvantage. For if there be any truth in the assertion that pathogenic germs are apt to be destroyed in a nutrient liquid like sewage, owing to the competing influence of their more hardy saprophytic neighbours, "delay" would seem to be an all-important factor.

The position of the bacteriologist would really seem to be this:—

Putrefaction cannot take place (whatever the number and sorts of bacteria present may be) in the absence of putrescible and oxidisable organic matter, and we have no direct means of estimating dead organic matter.

Indirectly, however, we can in most cases obtain a reliable indication of the degree of putrescibility of a liquid by estimating the number and observing the character of the bacteria contained in it.

In brief, our position as regards non-potable streams is very much that of the chemist in relation to drinking streams. In both cases the truth is sought for by necessarily indirect methods, and by assuming a relationship in the former case between the number of putrefactive bacteria and the amount of organic matter and in the latter case between the amount of organic matter and probable presence of microbes of pathogenic sort.

Up to the present the so-called incubator test has been largely practised by the chemist. But as it is based on the effect produced on the organic matter present in a liquid by the action of the bacteria in that liquid, it would seem to be a biological test.

In the present state of our knowledge it would seem unwise to reject altogether a bacteriological standard. It is impossible to forecast the future, and if a bacteriological standard can be brought into harmony with a chemical one it may be the means of strengthening our position and covering deficiencies in the chemical standard at present unforeseen and unsuspected. It must be remembered that the chemist in estimating the amount of organic matter is dealing with a substance about which he knows very little.

Moreover, the chemist can hardly, if at all, say of any effluent that it is insusceptible to putrefaction. All he can say is that under laboratory and artificial conditions of experiment it does not putrefy, and that his experience teaches him that a liquid having its particular chemical composition does not commonly give rise to an obvious or appreciable putrescent effect when discharged into an ordinary stream. It is always well to remember that a liquid giving rise to little or no appreciable smell when stored in a small bottle may yet conceivably when discharged into a river in huge bulk give rise to a very real and apparent nuisance.

Before leaving the subject note may be taken of the fact that some authorities assert that when an effluent is discharged into a non-drinking stream, it is both necessary and advisable that the bacteria which have been associated with its more or less complete purification should go with it also to continue their good work in the river. That it is necessary may be doubted, because river water already contains the microbes of putrefaction and nitrification. That it is advisable may conceivably be true, but there is no proof to show that such is the case.

In final summary it is to be noted:—

1. That both bacteria bed processes and land processes can yield effluents seemingly non-putrescible.

2. That in general the effluents from bacteria beds and from land are not to be thought of as safe in the case of drinking streams.

3. That chemical standards are essential in the case of potable and non-potable rivers.

4. That a bacteriological standard is most certainly indicated in the case of drinking streams, and is of more importance than the chemical one.

5. That a bacteriological standard is of secondary importance in the case of non-drinking streams, but may prove useful as an adjunct to the chemical standard.

A. C. HOUSTON.

February 26th, 1901.

Report on the Presence of Anthrax at Yeovil in (1) Septic Tank Liquor; (2) Septic Tank Sludge; (3) Primary Coarse Coke Bed; (4) Secondary Fine Coke Bed; (5) General Effluent from Final Catch-pit in a Hide Factory; (6) Mud of River Yeo; and (7) Mud of Yeo Brook.

By Dr. *Houston.*

On March 22nd 1901, Dr. McGowan visited Yeovil, and collected and transmitted to me samples of septic tank liquor and septic tank sludge. The results of the bacteriological examination of these samples led to my visiting Yeovil on April 12th with Dr. McGowan and Dr. Gordon. On April 24th and May 3rd Mr. Kershaw paid a third and fourth visit to Yeovil on behalf of the Commission, and besides collecting a number of samples, made certain inquiries of a useful kind, which I have incorporated in this Report (Addendum A).

Before entering into a description of the results of the experiments it is necessary to explain that the particular septic tank and coke beds have been out of use since last November, the reason being that the experiments which had been conducted during a period of about four years were considered by those in authority at Yeovil to be entirely satisfactory, and to justify the expenditure of a large sum of money on similar works, but large enough to treat the whole volume of Yeovil sewage, instead of only a section of it.* In the past, the whole bulk of Yeovil sewage has been discharged (and is now being discharged) *without any treatment*† either directly into the Yeo (the major portion) or indirectly into a brook (the minor portion) which joins the river Yeo above the main outfall.‡ The Yeovil sewage has the reputation of being excessively foul, and the foul character of the sewage is attributed to the large proportion of trade refuse present in it. The worst part of the trade refuse is derived from twelve or more hide factories, although two or more breweries play a minor part in rendering the sewage offensive. As regards the section of sewage treated in the experimental septic tank and coke beds, this was believed to contain more trade refuse relative to domestic sewage and surface water than will be the case when the total volume of sewage (all the domestic sewage, surface water, and trade refuse) is subjected to treatment at the proposed new works.

The following is a summary of the several sections of this Report:—

Part I. Relating to experiments with septic tank liquor and sludge collected on March 22, 1901.

Part II. Relating to experiments with samples collected from various sources on April 12, 1901.

Part III. Relating to experiments with other samples collected on the same date (April 12, 1901).

Part IV. Relating to experiments with samples collected by Mr. Kershaw on April 24, 1901.

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* It should be added that provision has been made for final treatment on land.

† Some years ago an attempt was made to treat the sewage with flour of lime.

‡ A consideration of this fact leads me to remark that however useful it may be to keep before one a counsel of perfection, it is imperative to avoid relegating to the background a common-sense view of the whole subject of sewage disposal.

PART I.—RELATING TO SAMPLES OF STAGNANT SEPTIC TANK LIQUOR AND SEPTIC TANK SLUDGE, COLLECTED BY DR. McGOWAN ON MARCH 22ND, 1901.*

Sample 1.—SEPTIC TANK LIQUOR.—The sample represented a mixture of liquid taken from different depths. (Namely, one, three, and five feet towards the upper end; and one, three, and four feet towards the lower end of tank.)

Experiment 1.—The bottle containing the liquid was shaken, and 4 cc. were injected subcutaneously into a guinea-pig. The animal died on the sixth day, and cultivations made from the heart's blood yielded a pure culture of the anthrax bacillus (B. Anthracis).

Experiment 2.—Same as Experiment 1, but only 2 cc. were used for inoculation purposes. The guinea-pig died on the seventh day. An examination of the heart's blood, splenic juice, etc., showed the presence of anthrax bacilli in great abundance. Cultivations were made from the heart's blood, and they yielded B. Anthracis in pure culture.†

Sample 2.—SEPTIC TANK SLUDGE.

Experiments 1 *and* 2.—The bottle containing the semi-liquid, black coloured sludge was shaken. When the grosser particles had subsided, a portion of the supernatant liquid was poured off, and 2 cc. (experiment 1) and 1 cc. (experiment 2) of this liquid were used for the subcutaneous inoculation of two guinea-pigs. The animals died respectively on the third and fourth day, and their blood and tissues were found to be teeming with B. Anthracis. Moreover, cultivations made from the heart's blood in each case yielded anthrax in pure culture.‡

These experiments form an important link in the chain of evidence which goes far to prove that, however great the advantages of the septic tank treatment of crude sewage may be from the chemical and practical point of view, the assumption that the process destroys all the pathogenic microbes of sewage is ill-founded and untrustworthy. It is true that the above experiments do not absolutely prove that the effluent from the septic tank contained B. Anthracis, but having regard to their positive character when dealing with comparatively small amounts of the tank contents, the presumption in favour of such a view is of the strongest kind.§ They, of course, conclusively proved that anthrax must have been present at one time in the section of Yeovil sewage treated in the septic tank.

PART II.—RELATING TO SOME OF THE SAMPLES COLLECTED DURING MY VISIT TO YEOVIL ON APRIL 12TH, 1901.

Sample (6).—*Coke in Coarse Bed* (*Number* 2).‖—The coke was dug up to a depth of about $1\frac{1}{2}$ feet, and the fragments mixed together so as to yield an average sample. Some of this mixed coke was placed in a wide-mouthed, stoppered bottle.

Experiment 1.—360 grammes of coke were placed in a wide-mouthed, stoppered bottle, and 36 cc. of sterile water added. The bottle was shaken vigorously for some time, and then left undisturbed for two days. Then another 72 cc. of sterile water were added, the bottle well shaken, and a portion of the liquid (coke "washings") poured off into a small beaker. After allowing the grosser particles to subside, about 10 cc. of the comparatively clear liquid were

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* Septic tank in operation about four years. At rest since last November, the liquid being left in the tank.

† The septic tank liquor strain of B. Anthracis will be hereafter referred to as strain I., *see* Figs. 1, 2, 3.

‡ The septic tank sludge strain of B. Anthracis will be hereafter referred to as strain II. (Figs. 4 and 5).

§ Proof, however, is furnished by the results of the coke-bed experiments.

‖ Said to have been treated with the septic tank effluent for four years. At rest since November, 1900.

decanted into a test tube. The tube was heated to 80 deg. C. for ten minutes so as to kill all the bacilli not present in the form of spores. 1 cc. of the surface liquid was withdrawn from the test tube by means of a sterilised glass pipette, and this was injected subcutaneously into a guinea-pig. The animal died on the second day, but I was unable to demonstrate the presence of anthrax either by examination of the blood and tissue juices, or by cultures therefrom.

Experiment 2.—In this experiment 10 cc. of the coke "washings" were poured off and diluted to 50 cc. with sterile water. After the grosser particles had subsided, 10 cc. of the liquid were decanted into a test tube, and the tube was heated to 80 deg. C. for 10 minutes. 1 cc. of the surface liquid was withdrawn from the tube and injected subcutaneously into a guinea-pig. The animal, however, eventually recovered completely from the effects of the injection.

Experiment 3.—5 cc. of the coke "washings" were poured off, diluted with sterile water to 10 cc., and heated in a test tube to 80 deg. C. for 10 minutes. 1 cc. of the surface liquid was used to inoculate (subcutaneously) a guinea-pig.

The animal died on the fourth day, and anthrax bacilli were present in large numbers in the blood and organs. Cultivations from the heart's blood yielded B. Anthracis in pure culture.*

The results of the last experiment proved conclusively that the septic tank effluent must occasionally, if not habitually have contained anthrax. It did not prove that the anthrax bacillus escaped in the effluent from the coarse bed.† But as we know that contact beds allow of the passage through them of bacteria of all sorts and of their spores in great abundance, it may be inferred that in all probability the effluent from the coarse coke beds occasionally or habitually contained the spores of B. Anthracis.

Sample (7).—Coke in Fine Bed (Number 8).‡—A mixed sample of the coke was obtained in the same way as in the case of sample (6).

Experiment 1.—620 grammes of the fine coke were placed in a wide-mouthed, stoppered bottle, and 62 cc. of sterile water added. The bottle was shaken repeatedly and then left undisturbed for two days. Next another 124 cc. of sterile water were added, and, after shaking vigorously, a portion of the liquid (coke "washings") was decanted into a small beaker. The grosser particles were allowed to subside, and afterwards 10 cc. of the comparatively clear surface liquid were poured into a test tube and heated to 80 deg. C. for 10 minutes. By means of a sterilised pipette 1 cc. of the surface liquid was withdrawn from the test tube, and this was injected subcutaneously into a guinea-pig.

The animal died on the second day, and its blood and organs were found to contain B. Anthracis in abundance. Cultivation made from the heart's blood yielded Anthrax (B. Anthracis) in pure culture.§

The result of this experiment affords adequate proof that the spores of B. Anthracis were not only stored in the coarse coke bed but came away in the effluent from that bed.

Summary at this Stage.

In summary at this stage it is to be noted that :—

(1) The liquor and sludge in the stagnant septic tank contained anthrax. Therefore the anthrax bacillus must at one time have been present in the section of Yeovil crude sewage treated in the septic tank.

(2) The coarse coke bed "washings" likewise contained anthrax, and therefore this pathogenic microbe must have been sometimes present in the septic tank effluent.

(3) The spores of the anthrax bacillus were also present in the fine coke bed "washings," and therefore they must have been present in the effluent from the coarse coke bed.

As the works were no longer in use, there was no way of proving by direct observation that the final effluent from the fine beds ever contained

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* The coarse coke bed strain of B. Anthracis will be hereafter referred to as strain III. (Figs. 6 and 7.)

† Proof, however, is furnished by the results of the fine coke-bed experiments.

‡ Said to have been "treated" with the effluent from the coarse coke bed for over twelve months.

§ The fine coke bed strain of B. Anthracis will be hereafter referred to as strain IV. (Figs. 8, 9, 10).

TABLE 1.—SHOWING CERTAIN FACTS AND INFERENCES TO BE DEDUCED FROM THE YEOVIL ANTHRAX EXPERIMENTS.

The Presence of Anthrax in—

The stagnant septic tank liquor and in the sludge	afforded proof of the presence at one time of anthrax in Yeovil crude sewage and	led to the inference that the septic tank effluent contained anthrax.				
The coarse coke bed			afforded proof of the presence at one time of anthrax in the septic tank effluent and	led to the inference that the coarse coke bed effluent contained anthrax.		
The fine coke bed					afforded proof of the presence at one time of anthrax in the coarse coke bed effluent, and	led to the inference that the fine coke bed effluent contained anthrax.

anthrax. But the presumptive evidence in favour of this is of so strong a kind that to hold an opposite view would be to take up, in my opinion, a quite untenable position.

The above facts and inferences are set forth in Table I. It will be seen that the only flaw in the line of argument is the absence of proof that the effluent from the secondary fine coke-bed contained, on occasion, anthrax From our knowledge of the biological qualities of the effluents from secondary fine coke bacterial beds, we may reasonably consider the chain of proof complete.

It is of some moment to avoid taking an extreme view, whether trivial or exaggerated, of the importance of these observations. To adopt a complaisant attitude would be to ignore the fact that *B. Anthracis* can give rise to a most dangerous disease in human beings, although happily only rarely and seldom so far as we know in epidemic form,* and also to place on one side the causal relation of anthrax to splenic fever, a most deadly scourge among cattle. But to take up an alarmist position in this matter would be equally harmful and inconsistent with the fact that, notwithstanding the discharge for many years of the *untreated* crude sewage of Yeovil into the River Yeo, no special and peculiar incidence of anthrax has, to the best of my knowledge, been traced to that particular source.†

I would rather from these experiments point out a general lesson, namely, that however satisfactory bacterial processes of purification may be from the chemical and practical points of view, they are not to be thought of as eliminating all risk of danger to health either as regards human beings or the lower animals.

Possibly the results of these experiments afford reasonable grounds for compelling particular manufacturers to undertake the sterilisation of trade refuse of a dangerous sort.

But the practical difficulties involved in the destruction of anthrax spores are, unfortunately, very great. Moreover, chemical or physical agents destructive of anthrax spores would also destroy most, if not all, the bacteria concerned in the bacterial purification of sewage.‡ Further, chemical substances markedly poisonous to animals and fish could hardly be employed with safety in all cases. If the amount of sterilised trade refuse gaining entrance into the sewers was small in relation to the total bulk of sewage this would, perhaps, not matter very much, as the sterilising substance would, applied in the manufacturer's premises, be so diluted at the outfall works as to weaken or destroy its antiseptic or injurious quality.

Again, if the chemical substance employed was one which, though used at the outfall, could be neutralised or got rid of in one way or another so far as its injurious qualities were concerned, the above objections would be removed. Unfortunately, it may be doubted if there are any germicidal agents known which are innocuous to man, the lower animals, and fish life, when used in the strength necessary to destroy anthrax spores.

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* Human *intestinal* anthrax is, fortunately, a very rare disease. But it is possible that unrecognised cases may sometimes occur. Butler and Karl Huber (quoted by Osler in his text book of medicine) described an epidemic in which twenty-five persons were attacked with intestinal anthrax after eating the flesh of an animal which had had anthrax. Six cases ended fatally. Infection of the human subject in nearly all cases is through the accidental inoculation of a surface abrasion, wound or pimple (malignant pustule), or else by the inhalation of the spores (pulmonary anthrax or wool-sorter's disease).

† Since writing the above, further enquiries have been made, and the results are not altogether reassuring. Although no cases occurring in human beings have been reported within recent years, the same cannot be said as regards the lower animals. Quite a number of cases of *alleged* anthrax have been reported from farms in the neighbourhood. The source of the infection is locally ascribed to (1) contamination of the river Yeo with trade refuse, and (2) the *extensive use* of the "refuse" from the hide factories as *field manure*. I consider it probable that the latter has been the main source of infection. In 1892, Somerset stood third among all the counties of England as regards the number of outbreaks of anthrax.

‡ Anthrax spores are said to be destroyed in a formalin solution of 1 : 1,000 in one hour. But my own experiments do not confirm this. Mercuric chloride is efficient in the proportion of 1 : 1,000, some say within a few minutes, others within half an hour, others again consider one hour's contact necessary. A 1 to 5 per cent. solution of calcium hypochlorite is necessary for the destruction of anthrax spores. Duration of contact variously stated ; some authorities consider a few minutes sufficient, others extend the time up to one hour.

Part III.—Relating to further Samples collected during my Visit to Yeovil on April 12th.

Series I.

Sample (1).—General Sewage (all domestic sewage, surface water, and nearly all trade refuse) near outfall into Yeo.

Experiment 1.—1,000 cc. of the liquid were placed in a Blyth's sedimentation apparatus. On the second day the deposit (about 3·5 cc.) was diluted to 10 cc., and then heated to 80 deg. C. for ten minutes in a test tube. 1 cc. of the surface liquid was withdrawn by means of a sterilised glass pipette, and injected subcutaneously into a guinea-pig. The animal died on the second day, but not from anthrax. Cultivations from the heart's blood yielded negative results.

Experiment 2.—A further experiment was made, but with a lesser quantity of the sedimented liquid. The animal, however, recovered completely.

Sample (2).—Brook Water.—This brook joins the River Yeo just above the main sewer outfall. It is seemingly not contaminated with domestic sewage, but two or more hide factories discharge their refuse into it.

Experiment 1.—The experiment was carried out in the same way as Experiment 1 Sample (1), except that the deposit (about 3·5 cc.) was not diluted. Further, after heating to 80 deg. C. for ten minutes in a test tube, the contents of the tube were shaken, and 1 cc. of the shaken liquid was used for inoculation purposes. The guinea-pig completely recovered from the effects of the injection.*

Series II.

Sample (3).—Semi-Solid Filth and Slime, held back by batten in manhole of sewer which previously supplied septic tank.

Sample (4).—Crude Sewage from the same place.

Sample (5).—Liquid from First Tank (Soak-pit) in Hide Factory (A.).—Situated lower down the brook than the septic tank. Represents the dirty liquid resulting from the first "washings" of a batch of hides.

Sample (8).—Surface Liquid in Septic Tank.

In each case a portion of the liquid† was heated to 80 deg. C. for ten minutes, and guinea-pigs were severally inoculated subcutaneously with 1 cc. The result was negative except as regards Sample (3), and here death was not due to anthrax.

Further experiments were made with Samples (4) and (5), but the liquid, instead of being shaken, was left at rest for seven days, and then part of it was poured off, and 1 cc. of the remaining liquid, which contained most of the suspended matter, was used for inoculation purposes. The result was negative as regards Sample (4), and although the guinea-pig inoculated with Sample (5) died on the third day, death was not due to anthrax.

Another experiment was also made with Sample (8), and here the liquid was not heated to 80 deg. C. for ten minutes, as in all the foregoing experiments. Further, the 1 cc. used for inoculation purposes contained more suspended matter than in the previous experiment with the same sample. The guinea-pig died on the third day, and, on examination, the heart's blood and spleen juice contained some bacilli which could not with certainty be said not to be anthrax. But cultures made from the heart's blood gave no growth, and death was doubtless due to some micro-organism other than B. Anthracis, probably a pathogenic anaerobe.

In summary of Part III. it is to be noted that all the samples yielded negative results as regards anthrax.

It was, perhaps, hardly to be anticipated that chance samples of the crude sewage and brook water should yield a positive result under the conditions of experiment. But the negative result in the case of Sample (5) is of considerable interest, since it seems to indicate that the foul liquid resulting from the primary process of steeping and washing a large number of hides need not of necessity contain anthrax.‡ Indeed, it gives rise to the supposition that the presence of anthrax is dependent on the introduction into the primary tank of a special batch of specifically contaminated hides. If this be true, then the danger in the case of a single factory may be only an occasional and accidental one.§ Nevertheless, the septic tank results lead

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* The difficulty in all these experiments was this :—If a large dose was employed, the animal was liable to rapidly die from the pathogenic effects of microbes other than anthrax. If a small dose was used, the chances of anthrax being present were correspondingly reduced.

† In the case of Sample (3) the liquid drainings from the semi-solid filth was used.

‡ It is here assumed, possibly without sufficient justification, that the primary tank would be specially liable to contain anthrax.

§ Too much stress, however, must not be laid on the results of the examination of a single sample.

one to suppose that, if anthrax was not commonly present in the trade refuse, its numbers on the occasions when it was present must have been very great. It must, however, also be taken into consideration that the septic tank and coke beds had been in operation for a very long period. In my previous writings (*e.g.*, *British Medical Journal*, Aug. 18th, 1900) I have hinted at the possibility of bacterial filters acting as a storehouse for pathogenic germs; and the same may be true as regards septic tanks and certain microbes. In this sense possibly the septic tank acted as a storehouse for anthrax spores, and, while allowing of the escape in the effluent of a certain number of them, yet held back the majority in the sludge at the foot of the tank. Even so, however, a time would doubtless arrive when the inflow to the tank and the effluent therefrom would contain an approximately equal number of spores. One alternative remains—namely, the possibility of anthrax multiplying in the septic tank. All that can be said in this connection is that our present conceptions of anthrax, when existing under saprophytic conditions, are in favour of its remaining alive only when lying dormant in the form of spores.* Moreover, the anaerobic conditions prevailing in the septic tank would seem to place the possibility of multiplication of this aerobe almost out of the question. The spores might, indeed, germinate into bacilli and the bacilli again form spores in the bacteria beds, but this appears to me to be very unlikely.† Nor is it probable that the above developmental changes could take place either in the tanks (in the hide factories) or subsequently in the sewers. There is reason to think that from first (*i.e.*, starting with the hides specifically contaminated with anthrax spores) to last (*i.e.*, ending with the presence of anthrax spores in the fine coke bacterial bed) little or no developmental change occurred of the nature of germination of the initial spores into bacilli, multiplication of these bacilli, and, finally, of their sporulation.

Part IV.—Relating to Samples Collected by Mr. Kershaw on April 27th, 1901.

Series I.

Sample (256).—Liquid from First Tank (soak-pit) in hide factory (B), situated above septic tank. The refuse from this factory formerly went into septic tank, and now is discharged into the brook. The liquor had been four days in contact with hides, and represents the dirty liquid resulting from the first "washings" of a batch of hides. Capacity of tank 6 feet by 6 feet, by 4 feet deep.

Sample (257).—Lime Liquor from Tank in same factory. This lime liquor had been in its tank six weeks, and hides out of it about three weeks.

Sample (258).—General Effluent from final Catch-pit (bran, lime, and soak-pit refuse) in same factory.

Sample (259).—Crude Sewage from last manhole at the outfall.

Sample (263).—Yeo Brook, which joins the River Yeo just above the main sewer outfall. Sample taken from a point near experimental works and below all the hide works which used to discharge into the septic tank and which now discharge into the brook.

In each case 700 cc. of the liquid were poured into sterile bottles.

As regards Samples 258 and 259 the bottles were shaken and 1 cc. used (without preliminary heating to 80 deg. C.) to inoculate guinea-pigs (g.p. 258 and g.p. 259).

As regards the other samples, the bottles were placed on one side for twenty-four hours to allow sedimentation to take place. Then a small portion of the sediment was in each case sucked up with a sterilised pipette and 1 cc. used (without preliminary heating to 80 deg. C.) to inoculate guinea-pigs (g.p 256; g.p. 257; and g.p. 263).

In two days g.p. 256 and g.p. 259 were dead, but not seemingly from anthrax. Cultures made from their heart's blood were sterile as regards B. Anthracis.

Guinea-pigs 257 and 263 eventually recovered from the effects of the injection.

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* It is perhaps hardly necessary to point out that anthrax within the animal body is always present in the bacillary form, never as spores. But the blood and discharges of affected animals contain the bacilli in great abundance, and on exposure to the air spores are readily formed. In this way hides become infected with the highly resistant spores of this pathogenic microbe. Splenic fever (anthrax in cattle) is not very common in this country, but abroad the disease occurs as a regular scourge. Unfortunately most of our hides are imported.

† As regards temperature, the limits of development are usually stated to lie between 12 deg. C. and 45 deg. C., and of spore formation between 18 deg. C. and 40 deg. C. But authorities differ on this point.

But guinea-pig 258 died on the fourth day, and on examination the blood and splenic juice were teeming with B. Anthracis. Cultures made from heart's blood yielded B. Anthracis almost in pure culture.*

Series II.

Sample (260).—Mud from the banks of the Yeo. 150 feet below sewer outfall.

Sample (261).—Ditto. About 1,150 feet below 260.

Sample (262).—Ditto. About 4,150 feet below 260.

185, 260, and 492 grammes respectively, of Samples 260, 261, and 262 were mixed (each in a separate wide-mouthed stoppered bottle) with 100 cc. of sterile water. After shaking for some time and then allowing the grosser particles to subside, a small quantity of the supernatant liquid was poured off, and 1 cc. (without preliminary heating to 80 deg. C.) was used to inoculate guinea-pigs (g.p. 260; g.p. 261; and g.p. 262).

Guinea-pig 261 recovered; g.p. 262 died on the eighth day, but not from anthrax.

But g.p. 260 died on the third day, and the heart's blood and spleen were found to be swarming with anthrax bacilli, and cultures from the heart's blood yielded B. Anthracis.†

The experiments were repeated as regards 261 and 262, somewhat large quantities being used. G.p. 261 recovered; g.p. 262 died, but not from anthrax.

In Summary of Part IV. it is to be noted that all the samples yielded negative results as regards anthrax with the exceptions of Sample 258 (general effluent from final catch-pit [bran, lime, and soak-pit refuse]), and Sample 260 (mud from the banks of the Yeo, 150 feet below sewer outfall).

The demonstration of anthrax in the mud of the River Yeo must not be taken as affording any proof that the final effluent from the fine coke-bed contained B. Anthracis. Although there can be little doubt that the fine-coke-bed effluent did contain the spores of anthrax (in view of their presence in abundance in the material composing the bed), it is highly probable that the presence of anthrax in the river mud was due to the continuous discharge into the River Yeo of untreated crude sewage and trade refuse.

Part V.—Relating to Samples Collected by Mr. Kershaw on May 3rd, 1901.

Sample (268).—Septic Tank Liquor taken 18 inches below the surface.

Sample (269).—Mud from banks of brook which joins Yeo lower down. Sample collected between last factory discharging into brook above septic tank and point opposite septic tank.

Sample (271).—From the same tank as Sample 256. Collected while the tank was being emptied.

Some of the liquid from the bottle containing Sample 268 was heated to 80 deg. C. for ten minutes. Then 10 cc. were centrifugalised, and 8 cc. poured off, and the remaining 2 cc. used to inoculate a guinea-pig. The animal eventually recovered from the effects of the injection. The experiment was repeated, but 50 cc. instead of 10 cc. were centrifugalised, and 48 cc. poured off, and 2 cc. used for inoculation, but the animal recovered.

From the results of the experiments with Sample (8), Series II., Part III., and Sample 268, Part V., it is evident that the spores of B. Anthracis cannot have been equally diffused throughout the whole contents of the septic tank.

405 grammes of Sample 269 were mixed with 100 cc. of sterile water in a wide-mouthed stoppered bottle. After shaking for some time the mixture was allowed to partially settle. Then 10 cc. of the comparatively clear liquid were syphoned off, heated to 80 deg. C. for ten minutes, and 1 cc. used to inoculate a guinea-pig. The animal eventually recovered from the effects of the injection. The experiment was repeated, but 2 cc. instead of 1 cc. were used for inoculation purposes. The animal died on the third day, and, on examination, the blood and spleen juice were teeming with B. Anthracis. Cultures from the heart's blood yielded B. Anthracis in pure culture.‡

As regards Sample 271, a portion of the liquid was heated to 80 deg. C. for ten minutes, and 1 cc. used to inoculate a guinea-pig, but the animal eventually recovered.

In summary of Part V. it is to be noted that only sample 269 yielded a positive result as regards anthrax. The mud was clearly contaminated from the two or three factories located higher up the brook than the septic tank.

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* This strain of anthrax will be hereafter referred to as strain V.

† This strain of B. Anthracis will be hereafter referred to as strain VI. (Fig. 11.)

‡ This strain of anthrax will be hereafter referred to as strain VII. (Figs. 12 and 13.)

These hide factories must necessarily from their situation have been those concerned in polluting the septic tank with the spores of B. Anthracis, for during the period when the septic tank was in operation, the refuse from these factories, instead of being discharged into the brook, was diverted into that section of the sewerage system leading to the septic tank.

A.—GENERAL SUMMARY.

In general summary of all the positive results, it is to be noted that seven strains of anthrax were obtained from seven different sources, as follows :—

Strain I. Septic tank liquor.
,, II. ,, sludge.
,, III. Washings of coke from primary coarse coke bed.
,, IV. ,, ,, secondary fine ,,
,, V. General effluent from final catchpit in a hide factory.
,, VI. Mud from the banks of the River Yeo.
,, VII. ,, ,, ,, Yeo Brook.

It has already been explained that the presence of anthrax in the septic tank proves, in the first place, that the section of sewage and trade refuse treated at the experimental works must at least occasionally have contained anthrax: secondly, that the presence of anthrax in the primary coarse coke bed proves that the septic tank effluent must at one time or another have contained anthrax; and, lastly, that the presence of anthrax in the secondary fine coke bed proves that the effluent from the primary coarse coke bed must at one time or another have contained anthrax.

The demonstration of anthrax in the general effluent from a final catchpit in a hide factory merely shows that the particular factory concerned must have been dealing with anthrax infected hides at one time, and probably at a period not far remote from the time when the sample was collected.

The presence of anthrax in the mud of the banks of the River Yeo and Yeo Brook is of considerable interest, and shows the great importance of examining in similar circumstances the sides and bed of a stream, as well as the flowing water.

The spores of anthrax are peculiarly resistant. That they would in the case of the Yeo be swept from the banks in time of flood and carried when present in the mud or river bank, down the river to be spread over low-lying land bordering the river hardly admits of any doubt. This seems a most serious matter, and certainly the "widening of the potentially infective anthrax area" by means of flood water is a subject which demands careful scrutiny. But it does not follow that a "potentially infective" area need ever become an "actually infective" one. It seems highly probable that with all diseases of bacterial origin a certain dose of poison is required to start the infective process. This may be less true with anthrax than in the case of some other diseases, but it holds good to some extent. It is by no means inconceivable that flood water while "widening the potentially infective anthrax area" might affect so wide a separation of the individual spores of anthrax one from the other as to largely remove the element of danger. Thus in the case of a low-lying pasture flooded with river water containing anthrax spores, the total number of anthrax spores deposited on the land might, if collected together, suffice for the infection of a large herd of cattle. But widely separated from each other, they might not readily infect grazing cattle, and even spores, like other matters, may in time undergo dissolution. It is here assumed, be it noted, that unless under very peculiar and special conditions the spores of anthrax remain dormant (under natural conditions) in the form of spores, and do not germinate into bacilli and multiply to any great extent if at all. It needs to be added that these remarks must not be read as implying that the presence of anthrax in

the various situations I found it to be in at Yeovil is unimportant. The contrary is the case, but it serves no useful purpose to magnify the danger and risk distorting things out of their true proportion. Excluding any case that may have arisen in the past from direct infection from handling the hides, and excluding also infection of cattle through grazing on land manured with the "refuse" from the factories, as foreign to the present inquiry, I am not aware that any special incidence of anthrax has been definitely traced in Yeovil or its neighbourhood to the discharge of untreated crude sewage and trade refuse into the river Yeo.*

It might have been anticipated perhaps that some of the strains of anthrax would have shown slightly diminished virulence as the result for example of prolonged sojourn in the septic tank and coke-beds. But unfortunately all the strains isolated were found to be of high virulence. Thus all the seven strains were subcultured in agar for one night at 37 deg. C. Seven mice were severally inoculated at the root of their tails with a platinum needle the point of which had been brought in contact with the growth on agar of one or other of the seven strains of B. Anthracis. The results were as follows :—

Strain	I.	Corresponding	mouse died in about 24 hours.
,,	II.	,,	mouse died in about 30 hours.
,,	III.	,,	mouse died in less than 24 hours.
,,	IV.	,,	mouse died in about 24 hours.
,,	V.	,,	mouse died in less than 24 hours.
,,	VI.	,,	mouse died in less than 24 hours.
,,	VII.	,,	mouse died in about 24 hours.

In supplement to the summary which has been given of the positive results, a reference is now made to some of the negative results.

Thus, although anthrax was found in the mud of the Yeo Brook and Yeo River within 150 feet of the main sewer outfall, negative results were obtained with two samples of mud collected, respectively 1,150 ft. and 4,150 ft. below the source of the last named sample.

Further, the spores of B. Anthracis were seemingly not distributed equally throughout the contents of the septic tank since samples 8 and 268 yielded negative results.

Lastly, negative results were obtained with a number of the samples notably number 5; as also with numbers 256 and 271 derived from the first "washings" of hides in the primary soak-pits, respectively of factories A (5), and B (256 and 271).

B.—CONCLUSIONS.

The new scheme for the disposal of Yeovil sewage provides for the treatment of the whole of the domestic sewage, trade refuse, and surface water, by means of septic tanks, and artificial filters with final disposal on land.†

From the results furnished in this report there are no good grounds for anticipating that the new scheme will remove the danger arising from the presence in the final effluent of living and virulent anthrax spores. That anthrax spores will eventually pass through the septic tanks, and bacterial beds can hardly be doubted. The land might possibly effect their mechanical separation if it were of good quality, but this would appear not to be the case. It must also be remembered that the grit chambers will require periodic cleansing, and that a time will come when the septic tanks and filter-beds will call for similar treatment, and that their contents will have to be disposed of. The question thus arises what action the Commission should take in this matter. It must be remembered that Yeovil is only one of a number of places where this question must of necessity be considered in the future.

* *See*, however, footnote (†) on page 5. † The land is stated to be not very suitable.

Three points appear to me worthy of consideration.

(1). Anthrax is a disease affecting man and other animals.

(2). The degree or probability of danger to man and animals at Yeovil.

(3). The question of what is practicable by way of remedy.

As regards (1) and (2) :—Intestinal anthrax in human beings is almost an unknown disease, although possibly cases may occasionally occur the true nature of which is not recognised. Further, the River Yeo is a non-drinking water stream. Infections through wounds, abrasions, or sores in connection with the discharge of sewage effluents into rivers may, perhaps, reasonably be ignored; or, at all events, regarded as of most unlikely occurrence. But bathing should certainly be prohibited in the neighbourhood of sewage outfalls in cases where the conditions are comparable to those pertaining at Yeovil. The danger, however, to human beings at Yeovil is to be looked for within the walls of the hide factories rather than outside them.

As regards animals the case is different, and there can be no doubt that here a real danger exists. That cattle drinking water containing anthrax spores or grazing on anthrax polluted land may become infected with anthrax is indisputable. Nevertheless, it must be borne in mind that a potential danger, seemingly of serious kind, may yet possibly never become an actual and tangible one. The incidence of anthrax on cattle in the neighbourhood is, in my opinion, to be ascribed rather to the manuring of the fields with refuse from the factories than to contamination of the River Yeo with the "untreated" crude sewage and trade effluents. Such an opinion, however, is necessarily little better than surmise, and without further investigation must be received with reserve.

As regards (3), no hopeful view can be expressed. To sterilise the whole of the sewage is out of the question; to sterilise the trade refuse alone seems impracticable.* It might be possible, although even this is doubtful, to sterilise a section of the trade refuse, namely, that portion most likely to contain the spores of anthrax. No process of sterilisation could reasonably be enforced which entailed a great expenditure, or which would be likely to injure the quality of the hides, or defeat the objects of the bacterial treatment of the sewage by destroying all the microbes in the general sewage.

The proprietors of a particular disinfectant on the market advise that hides should not be imported in a "sun-dried" condition, but should be painted over instead abroad with their preservative which they claim kills anthrax spores and leaves the hides in a more workable condition than if they were sun-dried.† The cost of such treatment is not serious, and if these claims be well founded, pressure might perhaps reasonably be brought to bear on manufacturers to induce them to require disinfected hides instead of sun-dried ones. The disinfectant in a 4 per cent. solution is said to be fatal to the spores of anthrax when infected hides are left soaking in it for one hour. This treatment is held to be non-injurious to the hides, and not very costly, and as it may be carried out by the consignee in this country may be suggested as an alternative to importing disinfected hides. The composition of the disinfectant is not stated, but it is admitted to be poisonous, which presents obvious disadvantages. It is proposed to test the germicidal value of a solution of this substance as regards anthrax spores, but there seems no easy way of ascertaining whether imported hides which have been "pasted" with the material abroad arrive in this country in a sterile condition as regards anthrax.‡

A considerable number of experiments have already been carried out with certain sterilising agents of comparatively speaking innocuous sort, but they are reserved for a special report on the sterilisation of effluents.

* The total volume of domestic sewage, manufacturing effluents (breweries and hide factories), and surface water amounts to about 143 million gallons per annum. The hide factory refuse amounts to about one-ninth part of the whole volume of sewage.

† After painting the hides with the preservative, natural or artificial, drying may be used, but "hard-drying" or "sun-drying" is not recommended.

‡ Since writing this Report the disinfectant has been tested with disappointing results.

I would urge somewhat strongly that the Commission should authorise me to inquire more fully into the matter, and to keep one or more factories under sustained observation so as to obtain some idea of the extent of the danger from anthrax and the best remedy.

Without making further inquiries and experiments, I am not prepared to express any decided opinion or come to other than tentative conclusions. The subject is indeed one which merits the most careful consideration on the part of the Commission.

In carrying out this piece of work I have received much valuable assistance from Dr. Gordon.

C.—*Description of Micro-Photographs.*

Fig. 1. B. Anthracis (Strain I.). Smear preparation; splenic juice of a guinea-pig that died after inoculation with 2 cc. of Yeovil septic tank liquor.

[Magnifying power, 500.]

Fig. 2. B. Anthracis (Strain I.). Portion of agar oblique culture, showing colonies of B. Anthracis in pure culture. From heart's blood direct of the guinea-pig referred to in description of Fig. 1. Two days' growth at 37 deg. C.

[Magnifying power, 3.]

Fig. 3. B. Anthracis (Strain I.). "Impression" preparation from a surface gelatine plate culture (24 hours at 20 deg. C.) stained with methylene blue. The same strain of anthrax as is referred to in descriptions of Figs. 1 and 2.

[Magnifying power, 55.]

Fig. 4. B. Anthracis (Strain II.). Smear preparation; heart's blood of a guinea-pig that died after inoculation with 1 cc. of Yeovil septic tank sludge.

[Magnifying power, 500.]

Fig. 5. B. Anthracis (Strain II.). Section of spleen of guinea-pig (referred to in description of Fig. 4), showing numberless anthrax bacilli.

[Magnifying power, 500.]

Fig. 6. B. Anthracis (Strain III.). Smear preparation; heart's blood of a guinea-pig that died after inoculation with the "washings" from a sample of the coke from the primary coarse coke-bed at Yeovil. Stained by Gram's method.

[Magnifying power, 500.]

Fig. 7. B. Anthracis (Strain III.). Section of lung of guinea-pig (referred to in description of Fig. 6), showing numerous anthrax bacilli.

[Magnifying power, 500.]

Fig. 8. B. Anthracis (Strain IV.). Gelatine stab culture; three day's growth at 20 deg. C. The culture was derived from a guinea-pig that died after inoculation with the "washings" from the secondary fine coke-bed at Yeovil.

[Magnifying power, $1\frac{1}{2}$.]

Fig. 9. B. Anthracis (Strain IV.). Section of liver of guinea-pig (referred to in description of Fig. 8), showing numerous anthrax bacilli.

[Magnifying power 500.]

Fig. 10. B. Anthracis (Strain IV.). Double-stained preparation showing spore-formation; from an agar culture (two days at 37 deg. C.). The same strain of anthrax as is referred to in descriptions of Figs. 8 and 9.

[Magnifying power, 500.]

Fig. 11. B. Anthracis (Strain VI.). "Impression" preparation of a colony of B. Anthracis (surface gelatine plate culture, 24 hours at 20 deg. C.). Stained with methylene blue. The culture was derived from a guinea-pig that died after inoculation with the "washings" of the mud of the bank of the River Yeo.

[Magnifying power, 250.]

Fig. 12. B. Anthracis (Strain VII.). Smear preparation; heart's blood of a guinea-pig that died after inoculation with the "washings" of the mud of the bank of the Yeo Brook. Stained by Gram's method.

[Magnifying power, 500.]

Fig. 13. B. Anthracis (Strain VII.). "Impression" preparation from a surface, gelatine plate culture (24 hours at 20 deg. C.). Stained with methylene blue. The same strain of anthrax as is referred to in description of Fig. 12.

[Magnifying power, 1,000.]

Addendum A.

*Note on the Process of Hide Dressing as practised at Yeovil.**

The raw hides (sheep and lambs) are all said to be imported from the Cape, Russia, and Spain, and they arrive in this country in a "sun-dried" state.

1. *Soak-Pit Process.*—A batch (about 600) of hides are placed in a tank or soak-pit (about 8 feet by 8 feet by 4 feet deep), and covered with heavy planks to prevent them from rising. The tank is filled with pure water (town supply); and, after twenty-four to forty-eight hours, or longer, the hides are fished out and transferred to a second and similar tank for a like period. Fresh water is used for each fresh batch of hides, and the dirty water escapes into a catchpit, if there is one, if not directly into the sewer or brook.

* The information contained in this brief note was obtained for me by Mr. Kershaw.

This soaking process cleans and softens the hides. While the hides are in the tank they are occasionally stirred about with a stout pole. The liquid from the soak-pits represents about one-fourth to one-fifth of the total volume of water used in dressing the hides. Antecedent to the next process, the hides are taken out of the soak-pit and scraped on a beam with a blunt draw-knife, and piled in heaps (flesh side uppermost) on the stone slabs adjoining the soak-pits.

2. *Arsenic and Lime Pasting Process.*—The hides are next pasted (on the flesh side) with a mixture of red arsenic (orpiment, obtained from Saxony) and lime. About 5 lb. of arsenic and a bushel of lime are mixed to a thin paste with water in a tub, and the mixture applied to the hides with a piece of sacking tied to the end of a pole. Each hide, after pasting, is folded once, and the hides are left piled in heaps for about twelve hours, when the depilatory action is sufficiently advanced to allow of removal of the hair by scraping the hair side of the hides on the beam. The wool or hair is rinsed, dried on a drying floor, and sold to make blankets, etc. The hides are then rinsed in tubs (rinsings go to sewers) and are ready for the next process.

3. *Lime Process.*—The hides pass through a series of tanks (four, about 7 ft. by 4 ft. by 4 ft.) containing lime in varying amount (about 4 bushels to each tank), and the process occupies about three weeks. After two batches of hides have been "treated" the liquid is allowed to run to waste to the catchpit or sewer or brook, and the tanks cleaned out and made ready with fresh lime for a fresh lot of hides. After the lime tanks the hides are again placed on the beam and scraped, but preparatory to this they are thoroughly rinsed in tubs containing clean water.

4. "*Puring*" *Process.*—The hides are next "treated" in a "puring" bath of dog dung and water contained in tubs, the liquid being kept at a certain temperature. The period varies (average about four hours) according to the quality of the hides. The foul liquid resulting from this process passes to the catchpit or sewer or brook. A fresh solution is used for every batch of hides. The "puring" bath brings the hides into a pliable and workable condition. It is doubtless a biological process, and the first and third processes probably involve bacterial action as well. After rinsing, the hides are ready for the next process.

5. *Bran Drench Process.*—The hides are soaked in tubs containing bran and water for some hours and again put on the beam and further cleansed and rinsed.

6. *Alum* (*etc.*) *Process.*—The hides are placed in revolving drums and a mixture of alum, salt, flour, and yoke of eggs forced into them. They are then stove-dried, and the "staker" next softens them in water and then stretches them on stakes. They are then ready to be dyed and afterwards made into gloves.

The effluents and "rinsings" from all the different processes are run off whenever convenient, either directly to the sewers or brook, or indirectly through a catchpit.

The total amount of water used in all the hide factories amounts to over sixteen million gallons per annum. Of this about one-fourth to one-fifth approximately comes from the soak pits and about one-fourth from the line tanks.

The total volume of domestic sewage, manufacturing effluents (breweries and hide factories), and surface water amounts to about 143 million gallons per annum. The hide factory refuse thus amounts to about one-ninth part of the whole volume of sewage.

December, 1901. *A. C. Houston.*

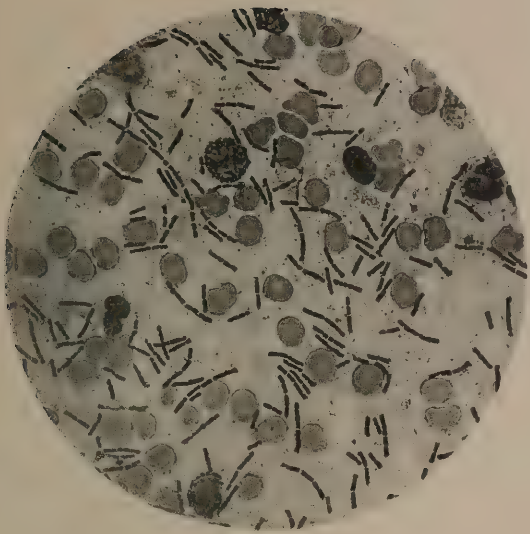
Fig 1.


Fig. 2.

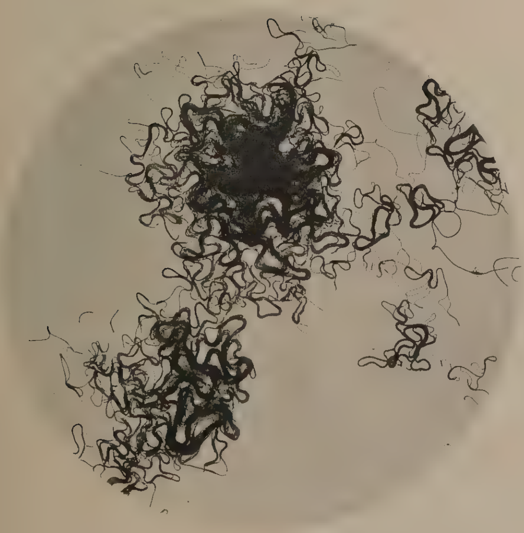
Fig. 3.


Fig. 4.

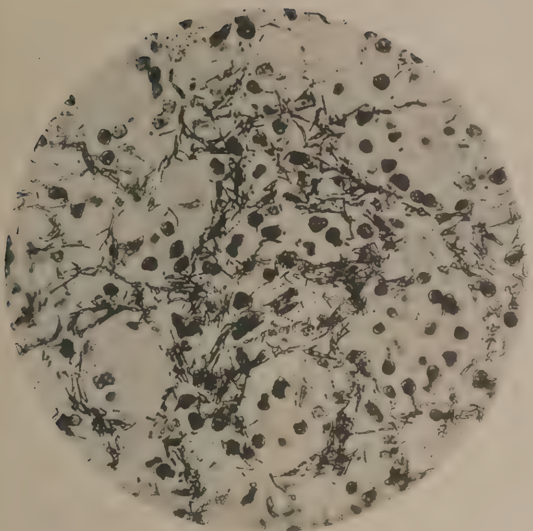

Fig. 5.

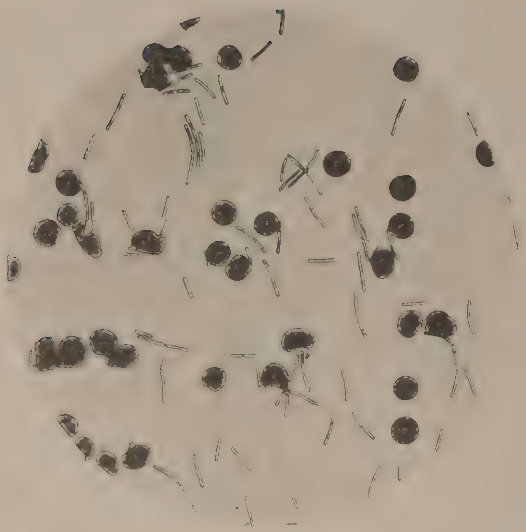

Fig. 6.

Fig. 7.

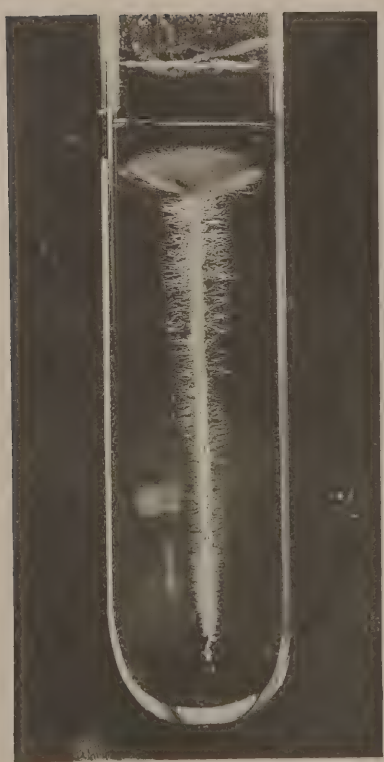

Fig. 8.

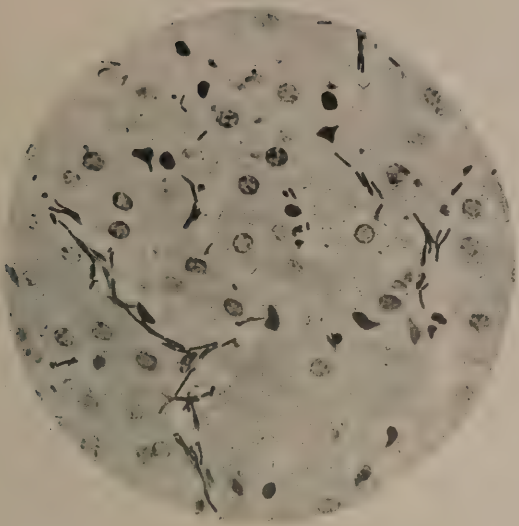

Fig. 9.

Fig. 10.

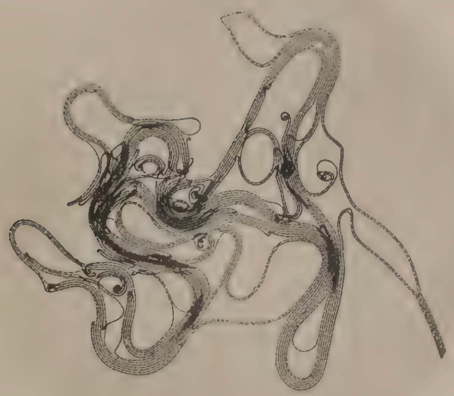

Fig. 11.

Fig. 12.

Fig. 13.

Report on the Results of the Subcutaneous Inoculation of Animals with Crude Sewage and with Effluents; Together with an Account of Detection of B. Pseudo-Tuberculosis and B. Pyocyaneus in some Samples of Sewage and of Effluents.

By Dr. *Houston.*

12*th February*, 1902.

This report can lay no claim to being a comprehensive study of the pathogenic qualities of sewage and effluents. The subject is a wide one, and to investigate it thoroughly would be the work of many years. But the esults obtained up to the present seem of sufficient importance to make it dvisable to place them on record.

The following is a list of the several sections of this report :—

I. Summary of previous work.
II. The subcutaneous inoculation of guinea-pigs with crude sewage and with effluents.
III. The subcutaneous inoculation of guinea-pigs with crude sewage previously heated to 80° C. for ten minutes.
IV. The subcutaneous inoculation of guinea-pigs with crude sewage previously heated to 100° C.
V. The subcutaneous inoculation of guinea-pigs with crude sewage after preliminary treatment as follows :—
  (*a*) Heated to 65° C. for twenty minutes and rendered germ-free by filtration through a sterilised Pasteur filter.
  (*b*) Heated to 80° C. for ten minutes and rendered germ-free by filtration through a sterilised Pasteur filter.
  (*c*) Heated to 100° C. for one hour and rendered germ-free by filtration through a sterilised Pasteur filter.
VI. The subcutaneous inoculation of guinea-pigs with crude sewage previously filtered through a sterilised Pasteur filter.
VII. The microbes concerned in producing the pathogenic results.
VIII. Pseudo-tuberculosis. B. pseudo-tuberculosis in sewage and sewage effluents.
IX. B. pyocyaneus in sewage and effluents.
X. Summary.
XI. Conclusions.

I.—*Summary of Previous Work.*

During 1898-99 I carried out a preliminary research on the subject of the bacteriology of sewage on behalf of the London County Council.

The following is a brief summary of the chief results then obtained :—

Injection of Crude Sewage and Effluents into Guinea-pigs.

A. The subcutaneous injection of Barking and Crossness crude sewage into guinea-pigs (about 1 to 3 cc. per 200 grms. weight), nearly always produced a local reaction, and not uncommonly death in from twenty-four to seventy-two hours. Sometimes the effluents from the coke beds were found to be more pathogenic than the raw sewage, but usually a somewhat larger dose of effluent than of sewage was required to produce a fatal effect.

B. If the injection of the crude sewage or effluent is not followed by fatal results within the first few days, the animal may occasionally die after the lapse of some weeks' time from pseudo-tuberculosis (*B. pseudo-tuberculosis* of A. Pfeiffer).

C. When the animal dies rapidly (twenty-four to seventy-two hours), virulent microbes, belonging to the class of B. coli and B. proteus may readily be isolated from the blood or tissues of the animal.

D. If the crude sewage or effluent be previously heated to 100° C. for one hour, large doses may be injected without producing a fatal result.

E. If the crude sewage or effluent be previously heated to 80° C. for ten minutes, a pathogenic effect may still be produced, but a much larger dose is usually required than when the liquid has not been so heated.

F. If the crude sewage or effluent be filtered through a sterilised Pasteur's filter, very large doses of the filtrate fail to produce a pathogenic effect.

The results that have since been obtained amply confirm the above statements. In addition some new information has been gained, notably as regards the presence of anthrax at Yeovil.*

Before considering the additional and confirmatory data it may be observed that the facts to be set forth not only show the actually dangerous qualities of some sewage effluents as regards rodents, but indicate also, and incidentally, for the same effluents possible danger to human beings. I say incidentally, because it does not, of course, follow that because an effluent produces a pathogenic effect when injected into rodents it would necessarily produce a pathogenic result if drunk by human beings. Nevertheless, we already know the dangerous qualities of sewage† in relation to human disease, and if the effluents from land and bacteria-bed processes of sewage treatment are apt to produce a pathogenic result equally with raw sewage when subcutaneously inoculated into rodents, the tentative inference is that it would be unwise to regard such effluents as being so altered by their treatment as to have ceased to be potentially dangerous in the case of human beings, however greatly the amount of their bacterial flora may be reduced.

As an index, then, of the retention by an effluent of the noxious qualities of its parent sewage and of the presence in it of undesirable microbes, the inoculation of animals is to be recommended, if not as a routine measure at least as an occasional test.

In this view of the case the pathogenicity of effluents in the case of rodents is significant, not because it, *pari passu*, directly points to danger in relation to human disease, but because it indirectly tends to show that a liquid (raw sewage), *not unknown* in its relation to human epidemic disease, has not, so far as the test on rodents may be taken as an indication, become so modified in its biological characters as the result of its treatment in bacteria beds or on land as to have altogether lost its potentially dangerous qualities.

I insist the more on this aspect of the question since it is constantly being urged, that in order to show the dangerous qualities of sewage effluents it is necessary to prove the presence in them of microbes pathogenic not only to the lower animals but also to human beings. With a view of illustrating the danger of accepting such contention as valid, I cite certain considerations that would seem parallel with those I have been advancing.

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* These results are given in a separate report.

† It cannot be too strongly insisted on that sewage is not a substance *untried or unknown* in its relation to human disease. It has for long been an established fact that sewage can spread epidemic disease, and that this is due to the organisms contained in it. The only point open to doubt is how far effluents are to be thought of in the same sense. It is for this reason that so much work has been undertaken in the endeavour to trace the extent to which sewage becomes, while the total amount of bacteria in it is being reduced, *modified in its biological characters* by the different methods of sewage disposal at present in operation.

Thus all chemical methods of seeking to ascertain the truth in the analysis of water are indirect ones. That is, the chemist estimates the relative proportions of certain substances present in a water, not because they are themselves harmful but because he knows from previous experience that they are an index of that which is harmful. We now know that the harmfulness thus indicated is due for the most part if not wholly, to living organisms. For example, of two waters, the first containing ten times as much organic matter as the second, other things being equal, the former must be likely to contain ten times more objectionable microbes than the latter. Yet no one doubts that, despite these limitations, the chemical analysis of water has contributed in the past in no small measure to secure the purity of our water supplies. Why then demand from the bacteriologist information which the chemist is powerless to furnish ?

The remarkable progress made in preventive medicine when chemistry was in the ascendant and bacteriology was comparatively unknown, was largely due to the recognition that excremental matters are a source of danger to health. Not that it was believed by sanitarians (at all events of recent times) that a single drop of sewage or even a single sample in bulk must necessarily be possessed of disease-producing power. But all the observed facts pointed in one direction, namely, that excremental matters are always *potentially* dangerous ; that if not actually dangerous on all occasions some time or other they were pretty sure to be associated with, *i.e.*, to carry along with them, the virus of disease. For example, it has been observed again and again that a water supply continuously polluted with excremental matters may be drunk for long periods with impunity, and yet may sooner or later give rise to epidemic disease. We now know that this change from potential to actual danger depends on the ordinary comparatively harmless bacteria of excremental kind being sometimes accompanied by microbes, also of intestinal outcome, derived from a diseased source and possessed of and retaining definitely pathogenic properties. At the period referred to (as now) chemistry played a most useful part. It was found that whereas crude sewage was rich in organic matter, pure waters—waters removed from all sources of objectionable contamination—were almost free from organic matter. And this being so, sanitarians naturally viewed all waters containing an undue amount of organic matter with much suspicion. In brief, the *status* of a water from the health point of view was then (as now) largely judged by the proportion of organic matter present. And the wisdom of the teaching of the earlier sanitarians has received ample confirmation from the discoveries of bacteriologists. Obviously, apart altogether from the value of chemical and bacteriological researches, epidemiologists, on the *basis of observed facts*, were and are clearly justified in regarding sewage and, in general, excremental matters as *always* a likely source of danger to health.

Reverting to the biological aspects of sewage, bacteriologists at present cannot draw a reliable distinction between sewage containing the actual specific germs of disease and sewage free from all microbes of definitely pathogenic sort, and therefore, comparatively speaking, unobjectionable. But if we regard sewage as always potentially dangerous, and dangerous, moreover, not because it contains organic matter, but because it harbours microbes of intestinal sort, the great value of bacteriological tests of sewage becomes at once apparent. Sewage is a substance teeming with bacteria of intestinal outcome ; with bacteria, that is, absent, or relatively so, from pure water. It is only necessary then to determine the kinds of bacteria of intestinal origin present in sewage, and their *relative abundance*, to obtain a series of data of the utmost value—data which, in my opinion, yield information of a much more trustworthy kind than mere chemical facts.* Early

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* Lest I be misunderstood, I must repeat the views I have already fully expressed to the Commission. In the case of drinking water streams, where the chief object is to guard against disease introduced into them by sewage, the bacteriological examination is of primary and the chemical examination is of secondary importance. But in the case of non-drinking water streams, where the main consideration is to avoid additions to the water of matters creating a serious nuisance, the converse holds good.

in 1898 a special research was carried out on these lines. Two microbes were selected, both typical of excremental matters, the one an aerobe (B. coli), and the other an anerobe (B. enteritidis sporogenes), and their *relative abundance* determined in multiple samples of sewage. Added to this, other lines of research bearing on the same subject were undertaken (e.g., as regards streptococci), but of these no special note need here be made. As the result of this work, it became possible to lay down certain bacteriological tests relating to crude sewage; to show the wide biological distinction between sewage and pure waters; to lay down a foundation for the subsequent examination of sewage effluents; and to enable a comparison to be drawn between sewage effluents and crude sewage as regards their probable degree of harmfulness. It was found that B. coli, B. enteritidis sporogenes, and streptococci ("microbes of indication")* were usually present in crude sewage in numbers exceeding 100,000, 100 to 1,000, and about 1,000 respectively per cc. As a contrast to these figures may be placed my experience as regards pure waters, namely, that these microbes are either altogether absent from them, or relatively so. With these records (previously lacking) made available, it became possible to judge the biological *status* of sewage effluents as regards their probable degree of harmfulness. The more nearly sewage effluents approached normal crude sewage standards the less could it be said that purification was satisfactory from the biological point of view, and the greater seemed to be their potential harmfulness. On the other hand, the fewer these "microbes of indication" were found to be, the more one felt justified in regarding such effluents as *relatively* safe.

To sum up, my propositions are briefly as follows:—

I have sought to show that sewage ought always to be regarded as a liquid potentially dangerous to health.

That sewage effluents which, so far as can be ascertained, resemble sewage in their biological composition ought also to be considered harmful; and that the inoculation of rodents is one way of obtaining information under this heading.

That there are tests available to the bacteriologist, which enable him to measure the degree to which an effluent agrees with or departs from normal crude sewage standards, and therefore to measure its probable degree of potential harmfulness, or, in other words, its *status* from the health point of view.

That it is not necessary to demonstrate in the effluent the presence of definitely pathogenic microbes to prove the element of danger. That on the contrary it is sufficient to show that bacteria indubitably of intestinal origin are present in an effluent to condemn it as potentially dangerous, for the reason that these micro-organisms are apt to be accompanied by bacteria well known to have caused disease in human beings.

[In much the same way, and in view of considerations broadly parallel, drinking-water has in the past been condemned (and rightly condemned) by the chemist because of undue presence in it of unoxidised organic matter, *not* by reason of any noxious quality ascertained to be bound up with the recognised adventitious material.]

II.—*The subcutaneous inoculation of guinea-pigs with crude sewage and effluents.*†

It has already been pointed out that that the subcutaneous injection of crude sewage into guinea-pigs nearly always produces a local reaction and not uncommonly death within a few days. Effluents naturally vary very

* "Microbes of indication" in the sense that these bacteria are intestinal germs apt to be associated with the pathogenic microbes which, by their occasional or frequent presence, may render sewage and sewage effluents actually dangerous.

† Unless otherwise stated, all the animals were inoculated subcutaneously in the groin.

much; while some equal crude sewage in their pathogenic qualities, others may be injected in large quantities without producing a fatal result. The effluents from land are usually less pathogenic than the effluents from bacteria-bed processes of sewage treatment. The following are examples both of pathogenic and of seemingly non-pathogenic, or at all events not markedly pathogenic samples.

Examples showing the pathogenic qualities of crude sewage and of effluents :—

Ducat's process at Hendon.—May 16, 1899.—20 cc. of the *effluent* were centrifugalised, 16 cc. were poured off, of the remaining 4 cc. mixed 2 cc. were used to inoculate a guinea-pig. The animal died on the 4th day.

Storm-water overflow. Altrincham Sewage Farm. April 29, 1900.—Two samples, 67 and 68; the former collected soon after the overflow had begun to work, the latter 1½ hours later. 2 cc. of each were severally injected subcutaneously into two guinea-pigs. Both died on the 3rd day.

Rugby. Street water from separate system after rain (96A).—June 20, 1900.—Two guinea-pigs were inoculated subcutaneously, the one (A) with 1 cc. the other (B) with 2 cc. Both had swollen bellies, but guinea-pig (A) eventually recovered. Guinea-pig (B) suffered from ulceration of the abdominal wall, and died on the 15th day.

S. Norwood. Street washings after running four hours.—Dec. 5, 1900.—Two guinea-pigs were inoculated subcutaneously, the one (A) with 1 cc. and the other (B) with 2 cc. of the sample. Although (A) guinea-pig eventually recovered it had a big swelling and was ill for some days. (B) guinea-pig died on the 2nd day.

Rugby. Street Washings during storm.—March 4, 1901.—A guinea-pig was inoculated subcutaneously with 4 cc. of the sample (231). It died on the 2nd day.

Rugby Sewage Farm.—March 7, 1901.—A guinea-pig was inoculated with 3 cc. of *crude sewage* (233). It died on the 2nd day.

Rugby Sewage Farm.—March 11, 1901.—A guinea-pig was inoculated with 2 cc. of *crude sewage* (235). It died on the 2nd day.

Exeter Septic tank effluent.—March 21, 1901.—A guinea-pig was inoculated subcutaneously with 2 cc. of sample. It died on the 4th day.

Luton Crude Sewage, 244A.—March 28, 1901.—A guinea-pig was inoculated subcutaneously with 3 cc. of the sample. It died on the 2nd day.

Ilford Crude Sewage.—August 27, 1901.—A guinea-pig was inoculated subcutaneously with 3 cc. of the sample. It died within 24 hours.

Ilford Crude Sewage.—September 6, 1901.—A guinea-pig was inoculated subcutaneously with 3 cc. of the sample. It died within 24 hours.

Examples showing that some effluents are not markedly pathogenic under the conditions of experiment :— *

Dibdin's process at Sutton.—June 29, 1899.—1 cc. of the *effluent* from a "fine bed" was injected subcutaneously into a guinea-pig. The animal recovered.

Leicester Sewage Farm.—Nov. 9, 1899.—2 cc. of the *final effluent* (No. 3) were injected subcutaneously into a guinea-pig. The animal recovered.

Leicester Sewage Farm.—Nov. 15, 1899.—2 cc. of the *final effluent* (No. 4), were injected subcutaneously into a guinea-pig. The animal recovered.

Nottingham Sewage Farm.—July 25, 1900.—A guinea-pig was inoculated subcutaneously with 4 cc. of *effluent* 111. There was no local reaction, and the animal was seemingly quite unaffected.

Nottingham Sewage Farm.—July 26, 1900.—A guinea-pig was inoculated subcutaneously with 8 cc. of *effluent* 113. It developed a big swelling and became quiet, but eventually recovered completely notwithstanding the large dose.

Beddington Sewage Farm.—Oct. 10, 1900.—Two guinea-pigs were inoculated subcutaneously the one with 1 cc. and the other with 4 cc. of *final effluent* 154. They were hardly, if at all affected, and both recovered completely.

South Norwood Sewage Farm.—Nov. 20, 1900.—Two guinea-pigs were inoculated subcutaneously, the one (A) with 1 cc. of *settled sewage* 176, the other (B) with 4 cc. of *final effluent* 178. (A) guinea-pig had a slight thickening at the site of the inoculation, but otherwise remained unaffected. (B) guinea-pig showed little or no reaction.

Rugby Sewage Farm.—February 18, 1901.—A guinea-pig was inoculated subcutaneously with 4 cc. of *effluent* 225. There was hardly any local reaction and the animal recovered completely.

Rugby Sewage Farm.—February 27, 1901.—A guinea-pig was inoculated subcutaneously with 10 cc. of *effluent* 230. The animal was seemingly but slightly affected. Fourteen days later it died, but on examination the organs seemed healthy (beyond some slight congestion of the lungs), and it is probable that death was not directly due to the effects of the injection

Rugby Sewage Farm.—March 5, 1901.—A guinea-pig was inoculated subcutaneously with 10 cc. of *effluent* 232. The animal was seemlingy unaffected and remained quite well for several weeks.

* Possibly some of the experiments included in this column may be considered to belong more properly to the left column or else to a separate column, standing as regards pathogenicity mid-way between the two.

S. Norwood settled Sewage (sample A).—September 10, 1901.—A guinea-pig was inoculated subcutaneously with 3 cc. of the sample. It died within 24 hours.

S. Norwood settled Sewage (sample D).—September 11, 1901.—A guinea-pig was inoculated subcutaneously with 3 cc. of the sample. It died within 24 hours.

S. Norwood settled Sewage (sample G).—September 12, 1901.—A guinea-pig was inoculated subcutaneously with 3 cc. of the sample. It died within 24 hours.

S. Norwood 1st field effluent (B).—September 10, 1901.—Two guinea-pigs were inoculated subcutaneously, one with 3 cc. and the other with 6 cc. of the sample. Both died within 3 days.

S. Norwood 1st field effluent (E).—September 11, 1901.—Two guinea-pigs were inoculated subcutaneously, one with 3 cc. and the other with 6 cc. of the sample. Both died within 2 days.

Rugby Sewage Farm.—March 6, 1901.—A guinea-pig was inoculated subcutaneously with 10 cc. of *effluent* 234. It was apparently unaffected and remained well for 24 days. It was then killed and examined; the organs were normal in appearance, but a small abscess was found at the seat of the inoculation.

Rugby Sewage Farm.—March 11, 1901.—A guinea-pig was inoculated with 10 cc. of *effluent* 237. It was but slightly, if at all affected, and remained well for several weeks.

Aldershot.—July 2, 1901.—*Street washings* during storm.—A guinea-pig was inoculated subcutaneously with 1 cc. of sample (311), There was some local reaction, but the animal eventually recovered completely from the effects of the injection.

Aldershot.—July 3, 1901.—*Street washings* during storm. A guinea-pig was inoculated subcutaneously with 2 cc. of sample (314). A localised swelling developed, but the animal eventually recovered completely from the effects of the injection.

S. Norwood 1st field effluent (H).—Collected during rainy weather.—September 12, 1901.—In this experiment guinea-pigs inoculated with 3 and 6 cc. of the sample recovered.

S. Norwood final effluents (C, F, & I).—Collected respectively on September 10, 11, and 12, 1901.—In each case two guinea-pigs were inoculated, one with 3 cc. and the other with 6 cc. of the sample. The animals, however, all recovered from the effects of the injections.

From the results of these experiments it is obvious that crude sewage is usually for rodents a highly pathogenic liquid. Further, that "street washings," storm water overflow liquid from sewage works, and bad effluents are also apt to be fatal on subcutaneous injection into guinea-pigs. Lastly, that some sewage effluents may be injected into these animals in relatively large amount without producing a pathogenic result.* Land effluents, so far as observed, are usually less pathogenic to rodents than effluents from bacteria-bed processes of sewage disposal.

III.—*The Subcutaneous inoculation of Guinea-pigs with crude sewage previously heated to* 80° *C. for ten minutes.*

As already indicated, if sewage be heated to 80° for ten minutes a pathogenic result may still be produced, but usually a larger dose of the liquid is required, and death is not so quickly induced.

The following experiments exemplify these facts:—

(1) *Rugby Sewage Farm*, February 18, 1901.—Some settled sewage (224) was heated to 80° C. for ten minutes, and then 4 cc. were injected subcutaneously into a guinea-pig. A slight swelling developed at the site of the inoculation, but the animal recovered completely.

(2) *Rugby Sewage Farm*, March 6, 1901.—Some crude sewage (233) was heated to 80° C. for ten minutes, and then 6 cc. were injected subcutaneously into a guinea-pig. The animal remained apparently unaffected. Half the dose (*not heated*) killed another guinea-pig in two days.

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* This latter circumstance must not be considered to yield any proof that such effluents are free from the presence of undesirable microbes. The test, indeed, is not a delicate one since effluents yielding unequivocal evidence by other methods of the presence of objectionable bacteria may yet yield on inoculation into rodents negative results. As regards many of the samples under scrutiny other biological data are available. These parallel observations are of such a nature as to lead to the conclusion that effluents in general do not give rise to an appreciable pathogenic effect on inoculation into rodents unless the number of undesirable microbes (*e.g.*, B. Coli) present in them run into hundreds or even thousands per c.c. and most certainly into figures which no responsible bacteriologist could accept as safe in the case of the discharge of an effluent into a drinking water stream, even if the dilution of the effluent with river water was much above the [illegible]rage.

(3) *Rugby Sewage Farm*, March 11, 1901.—Some crude sewage (235) was heated to 80° C. for ten minutes, and then 8 cc. were injected subcutaneously into a guinea-pig. The dose proved too large, and the animal died on the second day, notwithstanding the preliminary heating of the sewage.

(4) *Ilford Crude Sewage*, August 28, 1901.—Some of the sewage was heated to 80° C. for ten minutes, and then 5 cc. were injected subcutaneously into a guinea-pig. The animal showed some local reaction, but twelve days later was alive and well. 3 cc. of the same sample (*not heated*) killed another guinea-pig within twenty-four hours.

(5) *Ilford Crude Sewage*, September 6, 1901.—Some of the sewage was heated to 80° C. for ten minutes, and then 6 cc. were injected subcutaneously into a guinea-pig. The dose proved too large, the animal dying on the third day. 3 cc. of the same sample (*not heated*) killed another guinea-pig within twenty-four hours.

(6) *S. Norwood Settled Sewage*, sample A, September 10, 1901.—Same conditions of experiment as in experiment 5, but 5 cc. used for the injection. The animal recovered. 3 cc. of the same sample (*not heated*) killed another guinea-pig within twenty-four hours.

(7) *S. Norwood Settled Sewage*, sample D, September 11, 1901.—Same conditions of experiment as in experiment 6, and with same negative result. But 3 cc. of the same sample (*not heated*) killed another guinea-pig within 24 hours.

(8) *S. Norwood Settled Sewage*, sample G, September 12, 1901.—In this experiment 5 cc. proved fatal (second day), while 3 cc. of the same sample (*not heated*) killed another guinea-pig within 24 hours.

These experiments show that sewage, after being heated to 80° C. for ten minutes (this temperature would destroy bacilli, but not the spores of bacilli), is less pathogenic than sewage *not heated*, but that a fatal result may still be produced if the amount injected into the guinea-pigs be sufficiently great. Death, when it does occur, is usually less early with the *heated* than with the *not heated* sewage.

IV.—*The Subcutaneous Inoculation of Guinea-pigs with Crude Sewage previously heated to* 100° *C.*

It has already been said that if crude sewage be previously heated to 100° C. for 1 hour, large quantities may be injected without producing a fatal result. The following experiments serve as examples :—

(1) *Hendon Crude Sewage*, May 16, 1899.—Some of the sewage was heated to 100° C. for 1½ hours and 4 cc. were injected subcutaneously into a guinea-pig. The animal seemed rather quiet for the first day or two, but eventually recovered completely.

(2) *Ilford Crude Sewage*, August 27, 1901.—Some of the sewage was heated to 100° C. for one hour and 7 cc. were injected subcutaneously into a guinea-pig. The animal showed a slight local reaction, but twelve days later was seemingly quite well.

(3) *Ilford Crude Sewage*, September 6, 1901.—Some of the sewage was heated to 100° C. for one hour, and 10 cc. were injected subcutaneously into a guinea-pig. The animal seemed to be little, if at all, affected, and twelve days later was found to be quite lively and well.

(4) *S. Norwood Settled Sewage*, September 10, 1901. Sample A.—The experiment was carried out on exactly the same lines as recorded under experiment 3, and with the same negative result.

(5) *S. Norwood Settled Sewage*, September 11, 1901, Sample D.—Same negative result as A, experiment 4, under the same conditions of experiment, and with the same dose.

(6) *S. Norwood Settled Sewage*, September 12, 1901, Sample G.—Same negative result as A, experiment 4, under the same conditions of experiment, and with the same dose.

As regards experiments 2, 3, 4, 5, 6, three cc. of the same samples (*not heated*) in each case killed guinea-pigs within 24 hours.

The results of these experiments show that a three-fold lethal dose of sewage after preliminary heating to 100 deg. C. for 1 hour either produces no apparent effect on injection, or only a slight local reaction.

V.—*The Subcutaneous Inoculation of Guinea-pigs with Crude Sewage after preliminary treatment as follows :—*

(a) *Heated to* 65° *C. for* 20 *minutes, and rendered germ-free by filtration through a sterilised Pasteur filter.*

(b) *Heated to* 80° *C. for* 10 *minutes, and rendered germ-free by filtration through a sterilised Pasteur filter.*

(c) *Heated to* 100° *C. for* 1 *hour, and rendered germ-free by filtration through a sterilised Pasteur filter.*

(1) *Nottingham Crude Sewage*, September 26, 1901.—Three guinea-pigs (*a*, *b*, *c*), were inoculated each with 20 cc. of the filtered liquid under (a), (b), and (c) set of conditions. The animals were seemingly but little, if at all, affected by the injections, and remained lively and well*.

(2) *Leicester Crude Sewage*, October 12, 1901.—Experiment (1) was repeated, but Leicester, instead of Nottingham crude sewage, was used. The results were negative as in experiment (1).

These experiments seem to show that heating sewage under the above conditions of experiment does not set free any soluble poisons in such amount as to be capable of producing any appreciable pathogenic result when the filtered liquid is injected in large dose into rodents.

It has already been noted that sewage heated to 80° C. for 10 minutes remains in the *unfiltered* condition a liquid still possessed of pathogenic qualities, although a larger dose is required to produce a pathogenic result than when the liquid has not been so heated. From the results of the above experiments under (b) set of conditions it is obvious that the pathogenic qualities are not to be attributed merely to the heating setting free soluble poisons but to the vital activity of microbes present in the sewage in the form of spores.

VI.—*The Subcutaneous Inoculation of Guinea-pigs with Crude Sewage previously filtered through a Sterilised Pasteur's Filter.*

As previously explained, if crude sewage be filtered through a Pasteur filter, large doses of the filtrate may be injected into guinea-pigs without producing a fatal result. The following experiments may be cited in illustration of the truth of this observation :—

(1) *Hendon Crude Sewage*, May 16, 1899.—Some of the sewage was filtered through a sterilised Pasteur's filter, and then 4 cc. of the filtrate were injected into a guinea-pig. The animal remained seemingly quite unaffected.

(2) *Luton Crude Sewage*, March 27, 1901.—Some of the sewage (244A) was filtered through a sterilised Pasteur's filter, and then 20 cc. of the filtrate were injected subcutaneously into a guinea-pig. The animal remained apparently unaffected. Another guinea-pig inoculated with 3 cc. of the unfiltered sewage died on the second day.

(3) *Ilford Crude Sewage*, August 27, 1901.—Some of the sewage was filtered through a sterilised Pasteur's filter, and then 20 cc. of the filtrate were injected subcutaneously into a guinea-pig. The animal remained apparently unaffected.

(4) *Ilford Crude Sewage*, September 6, 1901.—Some of the sewage was filtered through a sterilised Pasteur's filter, and then 20 c.c. of the filtrate were injected subcutaneously into a guinea-pig. The animal remained apparently unaffected.

(5) *S. Norwood Settled Sewage*, Sample A, September 10.—The experiment was carried out under the same conditions as in Experiment 4, and with the same negative result.

(6) *S. Norwood Settled Sewage*, Sample D, September 11, 1901.—Same conditions of experiment as in Experiment 4, with the same negative result.

(7) *S. Norwood Settled Sewage*, Sample G, September 12, 1901.—Same conditions of experiment as in Experiment 4, with the same negative result.

(8) *S. Norwood Settled Sewage*, Sample J, September 18, 1901.—Same conditions of experiment as in Experiment 4, with the same negative result.

(9) *Nottingham Crude Sewage*, September 26, 1901.—Same conditions of experiment as in Experiment 4, with the same negative result.

(10) *Leicester Crude Sewage*, October 12, 1901.—Same conditions of experiment as in Experiment 4, with the same negative result.

As regards experiments 3, 4, 5, 6, 7, 8, three cc. of the same samples(*unfiltered*) proved in each case fatal on injection into guinea-pigs within 24 hours.

These experiments show that large doses of sewage rendered germ-free by filtration are seemingly innocuous when injected into guinea-pigs. Apparently about seven times an otherwise lethal dose of sewage may be injected in this manner without producing any very appreciable result.

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* In a previous experiment with S. Norwood crude sewage the liquid treated under (a) set of conditions did produce a pathogenic result. The animal died on the third day, and on examination showed thickening of the abdominal wall, intense congestion, and sanguineous exudation. In view of the wholly negative result obtained with Nottingham and Leicester sewage, it is probable that some additional factor must have intervened in this case.

VII.—*The Microbes Concerned in producing the Pathogenic Results.*

In a separate report the presence of anthrax in the septic tank and bacterial beds at Yeovil has been fully considered. In the present report the presence of B. pseudo-tuberculosis in some sewage effluent is dealt with.* But it is highly probable that as regards rodents the pathogenic qualities of sewage and sewage effluents are due to the vital activity of a large number of different microbes, some aerobic, others anaerobic; some spore-forming, others non-spore-forming. Further, that the pathogenic result is likely in most cases to be due to a mixed infection; that is, infection due to pathogenic bacteria of more than one sort acting concurrently.

In the case of those samples, previously heated to 80° C. for ten minutes, which, nevertheless, exercised a pathogenic effect when injected in gross amount, it is evident that the microbes at fault must have been spore-forming ones. It is not improbable that these may belong to the malignant œdema class of microbes, and possibly also B. enteritidis sporogenes may be concerned in producing the fatal result. But as has been already explained, the pathogenic action of sewage and effluents would seem to be principally due to the bacteria present as bacilli, not as spores, because a much smaller dose of sewage suffices to kill a guinea-pig when the liquid has not been previously heated to 80° C., and also death takes place, as a rule, more speedily.

As regards those samples (not previously heated to 80° C.) which proved fatal on injection into guinea-pigs, a number of microbes have been isolated from the blood and other tissues of the animal after death, some belonging to the B. coli class, others to the B. proteus group, yet others again to species which could not be identified.† Most of these microbes, when injected in pure culture into guinea-pigs, proved highly virulent. But as regards B. coli, at all events, there is always the possibility that the microbe isolated from the dead animal may not have really been derived from the sewage at all, but from the animal itself—that, in short, it may have been a strain of B. coli which had passed through the intestinal wall of the experimental animal and invaded the organs and tissues owing to their diminished resistance consequent on the injurious effects of the injection and the vital activity of the bacteria introduced with the material used for inoculation purposes. Even if this were not the case, the virulent character of the B. coli thus isolated may in reality be a property wholly or in part foreign to the B. coli introduced with the sewage; that is, the virulent character may conceivably be a property acquired during its temporary sojourn in the body of the animal, and the death of the animal may result largely, if not entirely, from the action of bacteria of different sort altogether. These are questions difficult, indeed almost impossible at the present time, to decide in a satisfactory manner. Nevertheless, if a guinea-pig succumbs within a few days after inoculation with sewage (a liquid known to be teeming with B. coli), if it be examined immediately after death, and if the predominant microbe isolated from the blood, tissues, or site of the wound is proved to be a highly virulent strain of B. coli, the inference is in favour of this microbe having been concerned in the infective process.

The whole subject merits further investigation, but the pressure of other work for the Commission—work likely to yield more immediately useful results—has prevented me so far from carrying out a more comprehensive research.

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* Two other microbes pathogenic alike to man and animals met with in my previous investigations may be mentioned. In one case a guinea-pig inoculated with a small quantity of the deposit collecting on the material composing a bacterial bed died of true tuberculosis (Koch's B. tuberculosis). In another instance two mice inoculated with the deposit from another bacterial bed died of tetanus (lockjaw).

† In one instance B. pyocyaneus was isolated from the heart's blood of a guinea-pig which had died after inoculation with 3 cc. of S. Norwood first field effluent B, September 10, 1901.

In conclusion, a single example may be given in illustration of this class of work :—

Exeter Septic Tank Effluent, March 21, 1901.—A guinea-pig was inoculated subcutaneously with 2 cc. of the liquid. It died on the fourth day. Cultures made from the heart's blood yielded a strain of B. coli, giving the following characters :—"Gas" in gelatine "shake" culture in 24 hours at 20° C. Diffuse cloudiness in broth cultures (at 37° C.) in 24 hours and indol on the fifth day. Strong acid and solid clot in litmus milk cultures (at 37° C.). $\frac{1}{8}$ cc. of a broth culture (24 hours at 37° C.) was injected subcutaneously into a guinea-pig. The animal died on the second day.

VIII.—*Pseudo-Tuberculosis.*

(*B. Pseudo-tuberculosis of A. Pfeiffer.*)*

As early in the work for the Commission as May, 1899, it was found that sewage effluents may contain B. pseudo-tuberculosis; and since then this pathogenic microbe has been found on more than one occasion to be present in the effluents from different processes of sewage purification. That it has not been found more often is probably due to the fact that animals inoculated with sewage effluents are apt to die before the slow B. pseudo-tuberculosis process of infection has been given an opportunity of developing. Further, even in those cases in which the animal recovers from the *primary* effects of the inoculation it is possible that the reaction at the seat of the inoculation produced by the numerous other microbes present may suffice to destroy there, the vitality of the B. pseudo-tuberculosis.

I.—*Ducat's Process.* May 2, 1899. Two cc. of the *effluent* from Ducat's filter at Hendon were inoculated subcutaneously into a guinea-pig. The animal died on the twentieth day from pseudo-tuberculosis. Fig. 1.

II.—*Dibdin's Process.* June 22, 1899. One cc. of the *effluent* from one of the secondary (fine material) bacterial contact beds at Sutton was injected subcutaneously into a guinea-pig. The animal died from pseudo-tuberculosis.

III.—*Nottingham Land Process.* December 6, 1899. Three cc. of *effluent* (No. 12) were injected subcutaneously into a guinea-pig. The animal died on the 30th day from pseudo-tuberculosis.

IV.—*Rugby Crude Sewage.* February 19, 1901. Two cc. of *crude sewage* (No. 224) were injected subcutaneously into a guinea-pig. The animal died on the 26th day from pseudo-tuberculosis. Figs. 2, 3, 4.

V.—*Exeter septic tank effluent.* March 21, 1901. Two cc. of septic tank *effluent* were injected subcutaneously into a guinea-pig. The animal died on the 19th day from pseudo-tuberculosis. Fig. 5.

It must not be concluded from these experiments that an effluent giving rise to pseudo-tuberculosis is *necessarily* a bad one. Quite the contrary may be the case. For example, in Experiment I. the effluent was a particularly good one.†

The real importance of these results lies in the fact that B. pseudo-tuberculosis is not only pathogenic to the lower animals, but also, it would seem, to human beings. It is true that the disease is believed to be a very rare one, but it is not impossible that the affection may in reality be less uncommon

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* Pseudo-tuberculosis (B. pseudo-tuberculosis of Pfeiffer), figures 1 to 5, must not be confused with true tuberculosis (tubercle bacillus of Koch), although the two diseases have many features in common (*e.g.*, the chronic nature of both affections, the occurrence of nodular deposits in various organs, etc.). Incidentally, however, it is of interest to note that on a single occasion a guinea-pig was successfully infected with true tuberculosis, the material in this case being the deposit collecting on the coke in a bacterial bed.

† That is, "good" for a sewage effluent, not "good" in the sense of being fit for domestic use.

than is at present supposed. In a recent report to the Local Government Board, Dr. Klein, speaking of the discovery by him that a by no means inconsiderable percentage of milk samples contains B. pseudo-tuberculosis, says: "I think it is not too much to say that the presence of the bacillus of pseudo-tuberculosis in milk may probably play a part in causing pseudo-tuberculous disease in the human subject."

It is noteworthy that pseudo-tuberculosis differs from many of the microbic affections that I have been dealing with in that it is one of the few diseases that can *readily* be transmitted to the lower animals by *feeding* experiments. Guinea-pigs fed on a *single* occasion with food material contaminated with B. pseudo-tuberculosis are apt to develop pseudo-tuberculosis.

The following is a description of the chief morphological and biological characters of B. pseudo-tuberculosis :—

B. PSEUDO-TUBERCULOSIS.*

Source.—Isolated from the spleen of a guinea-pig which died of pseudo-tuberculosis resulting from inoculation with Rugby settled sewage. Other strains of B. pseudo-tuberculosis obtained from the organs of guinea-pigs which had died of pseudo-tuberculosis after the injection of Exeter tank effluent, Dibdin's bacteria bed effluent at Sutton, etc., resembled this one in every respect.

Morphology.—Resembles B. coli somewhat closely. Short small bacilli occurring singly, in couples and short chains, with here and there a filamentous form. In broth culture the appearance is much more characteristic. Here, at first sight, one might almost be led to consider the microbe as a streptococcus, but on closer inspection it will be seen that the chains are composed, not of cocci, but short bacilli. This characteristic appearance is best observed in unstained preparations. In stained specimens the chain formation is much less noticeable. Figs. 2 and 3.

Motility.—Usually stated to be non-motile. Certainly most of the elements are non-motile, but it may be questioned if a few of them do not possess some degree of spontaneous motion.

Gelatine and agar plate cultures (20° C. and 37° C. respectively).—The growth resembles B. coli very closely, but the colonies tend to be more circumscribed and granular looking, and later they may present a tuberculated appearance, and show also some concentric ringing. The growth is also rather slower than B. coli, and the colonies have a more opaque and less filmy appearance. Nevertheless, the resemblance is a striking one.

Gelatine and agar oblique culture (20° C. and 37° C. respectively).—The growth resembles B. coli, but is more limited in extent, and is slower. The character of the growth is more opaque and less filmy than B. coli, and may show after some time a tuberculated appearance. Figs. 4 and 5.

Gelatine "shake" culture (20° C.).—No "gas" is formed, growth occurs throughout the tube.

Broth cultures (37° C.).—The growth is characteristic. In twenty-four hours there is diffuse cloudiness, but also well-marked granular cloudiness, and small flocculi are seen floating throughout the liquid.

Litmus milk cultures (37° C.).—For one or several days there is no visible change. Later, a trace of alkali appears, and the alkaline change becomes daily more decided until it is striking and unmistakable.

Animal experiments.—Guinea-pigs inoculated subcutaneously with a small amount of a culture die within a few weeks. Their organs are found to be studded with yellowish white nodules, containing B. pseudo-tuberculosis in pure culture. Figs. 1 and 5. Guinea-pigs fed with food contaminated with a culture of B. pseudo-tuberculosis die somewhat more quickly, and nodular deposits may readily be seen in the walls of the small intestine and in the mesenteric glands.

IX.—*B. Pyocyaneus in Crude Sewage and Effluents*†.

In the London County Council Experiments (1898-9) B. pyocyaneus was on rare occasions found in the crude sewage and effluents from the bacteria beds. Since then a careful look-out has been kept for this pathogenic microbe, but it has not been found to be present in crude sewage and sewage effluents except in rare cases. But it is quite possible that it may often have escaped notice owing to the enormous number of other bacteria present in the cultures. B. pyocyaneus is a microbe of virulent sort in the

* In a recent report to the Local Government Board Dr. Klein gives an exhaustive account of the morphological and biological characters of B. pseudo-tuberculosis.

† It is convenient to include these results in this Report, although perhaps, strictly speaking, they ought to come under a separate category

case of rodents, and it is not uncommonly found to be associated with other pyogenic bacteria in abscesses (bacillus of green pus) and other morbid processes occurring in the human subject. B. pyocyaneus is a chromogenic microbe, producing in various media a characteristic fluorescent green colouration. It differs from the ordinary liquefying fluorescent bacteria (B. fluorescens liquefaciens and its allies) so commonly met with in water, soil and sewage cultivations in a number of important respects. For example, the ordinary liquefying fluorescent bacteria as a rule grow feebly or not at all at blood heat, are not pathogenic, and do not give rise to the same tint of green in culture media. B. pyocyaneus on the other hand, grows luxuriantly at blood heat and produces at that temperature, as well as at lower temperatures, a characteristic dark olive green colouration in agar cultivations. Moreover, if 0·5 cc. (a much smaller amount may suffice) of a 24 hours broth culture (at 37°C.) be injected subcutaneously into a guinea-pig, the animal dies usually in less than 24 hours, and a cultivation made from its heart's blood yields B. pyocyaneus in pure culture.

The following is a brief account of the work done in this direction :—

Experiment 1, *Hendon Crude Sewage*, May 31, 1899.—B. pyocaneus present in $\frac{1}{100000}$ cc.. On 0·5 c.c. of a 24 hrs. broth culture of this microbe being injected subcutaneously into a guinea-pig, the animal died within 24 hrs. B. pyocyaneus was recovered from the heart's blood in pure culture.

Experiment 2, *Ducat's bacteria bed effluent corresponding* to crude sewage, Experiment 1, May 31, 1899.—B. pyocyaneus present in $\frac{1}{2000}$ cc. On 0·5 cc. of a 24 hrs. broth culture being injected subcutaneously into a guinea-pig, the animal died within 24 hrs. B. pyocyaneus was recovered from the heart's blood in pure culture. *See* Fig. 6.

Experiments 1 and 2 are of special interest. Dr. Gordon carefully determined the number of B. pyocyaneus in the crude sewage and in the effluent. The reduction number in the effluent was 98 per cent. The total number of bacteria (agar at 37° C.), in the crude sewage and effluent was respectively 3,070,000 and 77,000 per cc., a reduction of over 97 per cent. Here then we have a remarkable instance of a particular microbe, and moreover a pathogenic one, present in the crude sewage, being reduced in almost exactly the same proportion as the total number of microbes was reduced by the bacteria bed treatment of the sewage.

The question is frequently asked—are the microbes appearing in a particular sample of effluent *corresponding* to a particular sample of sewage, simply the bacteria contributed along with that sewage and which have passed the barrier of the bacteria bed ; or are they the progeny of these same bacteria ; or, lastly, are they microbes related to sewage reaching the bed days, or even weeks beforehand ? The subject is a most intricate one, but it seems reasonable to suppose that in a bacteria bed there are processes leading to loss of vitality as well as conditions favouring multiplication ; that although many of the microbes present in the crude sewage pass directly through the bed, some are retained, and that there is a constant washing out of some of the bacteria held back in the bed and related to previous samples of crude sewage. In this view of the case the bacteria in a particular effluent represent for the most part the bacteria of the *corresponding* sample of crude sewage, together with some microbes washed out of the bed, which really belong to past samples of sewage. The matter is complicated by the possibility or probability of microbes of different species behaving in a quite different fashion during the process. In the case of a bactoria bed yielding uniformly an effluent containing much fewer bacteria than the crude sewage, we must assume either that the bacteria are mechanically held back and gradually accumulate until the bed chokes,* or else that a stage is reached in the history of a bed when the rate of decay of bacterial life in the bed is equivalent to the observed percentage reduction in the number of micro-organisms in the effluent as compared with the crude sewage. The subject is one of great importance, because if it could be shown that the bacteria in a particular effluent were not. for the most part, related to the bacteria in the *corresponding* sample of sewage, but were derived from the storage in the bed of the micro-organisms of much earlier samples of crude sewage, it might be contended that this circumstance was in favour of the possibility of pathogenic microbes being destroyed or their virulence inhibited in the process. But it is greatly to be feared that the bulk of bacteria in a particular effluent bears a direct relation to the bacteria in the *corresponding* sewage, and experiments 1 and 2 seem to favour this view. For the crude sewage contained 3,070,000 bacteria and 100,000 B. pyocyaneus, and the effluent 77,000 bacteria and 2,000 B. pyocyaneus per cc., a percentage reduction of 97 and 98 respectively. It must be remembered that B. pyocyaneus is only rarely met with in sewage and sewage effluents, so that the 2,000 B. pyocyaneus in the effluent were directly related to the 100,000 in the corresponding sample of crude sewage hardly admits of any doubt.

The plain facts of the case are sufficiently striking, namely, that a pathogenic microbe was present in the effluent in exactly the same proportion relative to the total bacterial flora as in the crude sewage.

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* Possibly during storms, when the volume of sewage becomes much increased, the bacteria in the case of "continuous flow" beds are "washed out" in great numbers.

It must not be supposed that because an effluent contains B. pyocyaneus it is necessarily worse than other effluents in which B. pyocyaneus cannot be found. In the present case the effluent under consideration showed a high percentage degree of biological purification, and, moreover, B. pyocyaneus is seldom met with in crude sewage. The lesson to be learnt is obvious, namely, that the results of the above experiments form a link in the chain of evidence which goes far to prove that the effluents from bacterial beds cannot reasonably be assumed to be uniformly more safe (except, perhaps, as regards *amount* of undesirable microbes) than sewage.*

Experiment 3.—*Croydon Sewage Farm, effluent* 23, January 10, 1900.—B. pyocyaneus present in 1 c.c. 0·5 cc. of a twenty-four hours broth culture injected subcutaneously into a guinea-pig. The animal died within twenty-four hours. B. pyocyaneus was recovered from the heart's blood in pure culture.

Experiment 4.—*Rugby Sewage Farm, crude sewage* 93, June 20, 1900.—B. pyocyaneus (? variety) present in $\frac{1}{100}$ cc. 0·5 cc. of a twenty-four hours broth culture was injected subcutaneously into a guinea-pig. The animal died within twenty-four hours. The same microbe was recovered from the heart's blood in pure culture. This microbe differed somewhat from the typical B. pyocyaneus, inasmuch as the green colour produced in agar cultures was of a paler tint than normal.

Experiment 5.—*Ducat's Filter Effluent at Hendon*, July 18, 1900.—A microbe (? variety of B. pyocyaneus) was present in 1 cc., which seemed at first to be typical of B. pyocyaneus. But it was not virulent in broth culture, hardly even feebly pathogenic.

Experiment 6.—*Leicester Sewage Farm, effluent* 137, September 12, 1900.—B. pyocyaneus present in $\frac{1}{10}$ cc. 0·5 cc. of a twenty-four hours broth culture injected subcutaneously into a guinea-pig. The animal died within twenty-four hours. B. pyocyaneus was recovered from the heart's blood in pure culture.

Expesiment 7.—*S. Norwood Sewage Farm, effluent from first field*, September 10, 1901.—Sample B.—This experiment differed from the preceding inasmuch as B. pyocyaneus was isolated from the animal after inoculation with the effluent. 3 cc. of the effluent were injected subcutaneously into a guinea-pig. The animal died on the third day, and from its heart's blood a pure culture of B. pyocyaneus was obtained.

X.—*Summary.*

In general summary of the foregoing results the following points seem worthy of note :—

(1) The subcutaneous injection of crude sewage into guinea-pigs (about 1—3 cc. per 200 grammes body weight) always produces a local reaction and not uncommonly death within 24—72 hours.

(2) "Street washings," storm-water overflow liquid from sewage works, and in general bad effluents, are also apt to be pathogenic under the above conditions of experiment.

(3) Good effluents may be injected in relatively large amount without producing a fatal result.

(4) Land effluents, in my experience, are usually less pathogenic than effluents from bacteria-bed processes of sewage disposal.

(5) If sewage or effluents be previously heated to 80° C. for 10 minutes a pathogenic result may still be produced, but usually a much larger dose of the liquid is required.

(6) If sewage or effluents be previously heated to 100° C. for one hour large doses of the liquid fail to produce a pathogenic effect.

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* The question of dose or amount of morbific poison is not forgotten. This consideration and others of similar sort must needs, in the future, be brought to bear on the subject when it is considered in a broad and general way and when all the chemical and bacteriological records are available. In the meantime I am largely considering effluents by themselves, apart from controlling influences, which, it is to be feared, despite their importance, are not easily capable of estimation or expression either in general or particular cases.

(7) Sewage rendered germ-free by filtration through a sterilised Pasteur filter may be injected into guinea-pigs in large amount without producing any appreciable result. Preliminary heating of the sewage to (*a*) 65° C. for 20 minutes, (*b*) 80° C. for 10 minutes, (*c*) 100° C. for one hour does not seem to affect this negative result.

(8) Some samples of sewage and effluent contain B. *pseudo-tuberculosis* and some B. *pyocyaneus*. Both these microbes are highly pathogenic to lower animals, and are also related to morbid processes occurring in the human subject.

XI.—*Conclusions.*

To apply the results obtained by the subcutaneous inoculation of the lower animals with sewage and with effluents *too closely* to the conditions affecting or likely to affect human beings would be obviously injudicious. But the results as a whole lend themselves to certain inferences even if these be only regarded as of a provisional kind.

In the first place, the pathogenic qualities of most sewage effluents under the conditions of the experiments point to the improbability of sewage being so modified in its biological characters by treatment on land or by artificial processes as to be other than a liquid relatively still potentially dangerous to human beings. The absence of a definitely pathogenic result on rodents in the case of some sewage effluents is in all likelihood and in most cases merely an indication of their comparative not their absolute harmlessness to these animals.*

Secondly, the absence of any pathogenic result when sewage (heated or unheated) is rendered germ-free by adequate filtration is to some extent reassuring as tending to show that the chemical products of the vital activity of the bacteria in sewage are not of a markedly poisonous nature. That is, non-poisonous under the condition of experiment and in the case of rodents. It does not necessarily follow that the filtered sewage would be altogether harmless if drunk by human beings, however probable this may seem to be.

Thirdly, it is of interest to note that although the bacteria present as *bacilli* were most active in producing a pathogenic result, the microbes present as *spores* were also virulent, provided the dose employed was sufficiently large.

Fourthly, the presence of B. *pseudo-tuberculosis* and B. *pyocyaneus* in some sewage effluents is important in view of the fact that these microbes have been found to be related to morbid processes occurring in the human subject. It may, moreover, be of significance in relation to human disease that the former microbe is fatal to rodents when mixed with their food.

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* It is, however, not inferred that because an effluent is fatal when inoculated into rodents it is necessarily dangerous if drunk by human beings. The contention is that untreated sewage must from past experience be accepted as a potentially dangerous liquid in relation to human disease, and that the inoculation of rodents is merely a way of testing how far sewage has become modified in its biological characters as the result of treatment on land or in bacteria-beds. If effluents equally with crude sewage are found to be pathogenic to rodents, then we may risk the assertion that, as no modification is apparent as regards rodents, it would be wise to regard such effluents in the same category as crude sewage in relation to potential danger to human beings. The important question of dilution is not lost sight of. But, as a starting point, it is desirable to consider effluents in the abstract sense, unfettered by attention to factors which must needs vary in different cases, and also in individual cases, from time to time. Questions of dilution, &c., may, and indeed should, in my opinion, be subsequently brought to bear on the subject by way of modifying or correcting provisional inferences. Nevertheless, I would urge that questions of dilution, percentage purification, and the like, are of more importance from the chemical than the biological point of view. Mere dilution, apart from biological modification is a dangerous element to rely on. The history, for example, of "water epidemics" would not seem to place a high value, if I may so express it, on dilution, unaccompanied by any other restraining influence.

Lastly, these conclusions must be interpreted in a relative sense. The admittedly artificial character of my experiments and the fact that I have dealt with effluents by themselves and not effluents diluted and altered by mixture with river water and exposed to other conditions of a sort likely to restrain or destroy their pathogenic qualities may, I think, reasonably be adduced as arguments against accepting without qualification even the cautious inferences that I have tentatively advanced.

Fig. 1.

From a section through the spleen of a guinea-pig which died from pseudo-tuberculosis after having been inoculated subcutaneously with the effluent from Ducat's filter at Hendon. The figure shows numerous bacilli (B. pseudo-tuberculosis).

[Magnifying power, 1,000.]

Fig. 2.

Microscopic preparation from an agar culture (24 hours at 20° C.) of B. pseudo-tuberculosis. This microbe was isolated from the spleen of a guinea-pig which died of pseudo-tuberculosis after having been inoculated subcutaneously with Rugby settled sewage.

[Magnifying power, 1,000.]

Fig. 3.

Microscopic preparation from a broth culture (24 hours at 20° C.) of B. pseudo-tuberculosis. The same strain as is shown in Fig. 2.

[Magnifying power, 1,000.]

Fig. 4.

B. pseudo-tuberculosis in gelatine oblique cultures. The left tube represents a 48 hours (at 20° C.) streak culture. The middle tube represents a 72 hours (at 20° C.) streak culture. The right tube shows the colonies of B. pseudo-tuberculosis after 48 hours' growth at 20° C. The same strain as is shown in Fig. 2.

[About natural size.]

Fig. 5.

Colonies of B. pseudo-tuberculosis growing in gelatine oblique culture (5 days' growth at 20° C.). The left and right tubes were directly inoculated respectively from nodules in the liver and spleen of a guinea-pig dead of pseudo-tuberculosis after having been inoculated subcutaneously with Exeter septic tank effluent.

[About natural size.]

Fig. 6.

B. pyocyaneus; microscopic preparation from an agar culture (24 hours at 20° C.) stained by V. Ermengem's method to show flagella by Dr. Gordon. The agar culture was derived from the heart's blood of a guinea-pig which had died within 24 hours after inoculation with 0·5 c.c. of a 24 hours (at 37° C.) broth culture of B. pyocyaneus. The strain of B. pyocyaneus was obtained from $\frac{1}{2000}$ c.c. of the effluent from Ducat's filter at Hendon.

[Magnifying power, 1,000.]

12th February, 1902. A. C. HOUSTON.

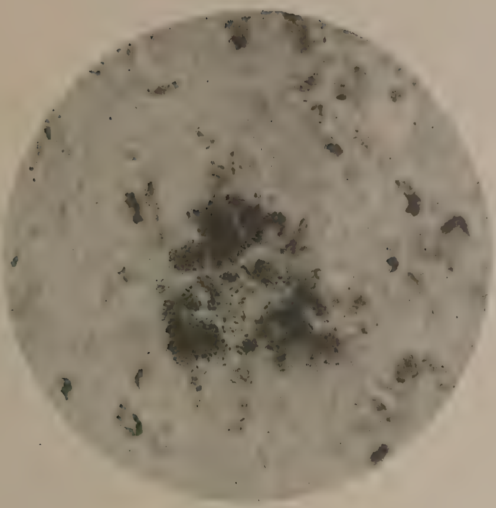

Fig. 1.

Fig. 2.

Fig. 4.

Fig. 5.

Fig. 3.

Fig. 6.

EXPERIMENTS ON THE LONGEVITY OF THE BACILLUS TYPHOSUS IN SEWAGE AND SEWAGE EFFLUENTS.

By Alfred MacConkey.

Reasons for the Investigation.

It having been shown that the final effluent from the various biological methods of sewage treatment very often contained the B. coli in large numbers; in other words that not all the intestinal parasites which left the alimentary tract of man and animals were got rid of in the methods employed, the question naturally has occurred whether if the bacillus of typhoid fever found its way into bacterial beds it would survive and pass into the effluent, and so constitute a danger.

In the series of experiments upon the effect of filtration on sewage effluents and of dilution (River Severn observations) upon sewage, which the Royal Commissioners have already received from us, it was shown that the B. coli tended to die out both in the earth and sand composing the filters, and in the water and mud of the River Severn. It was explained, that once outside the alimentary tract the B. coli was not in the most suitable environment for its multiplication, and that the innumerable coarser bacteria of putrefaction, in their rapid multiplication, used up the food materials, and produced products which were in all probability injurious to the more sensitive B. coli. If in this struggle for existence the bacillus coli is outdistanced by coarser bacteria, and soon perishes, there is still more reason why the bacillus of typhoid should not long survive outside the alimentary tract. The reason for supposing this is that it has been shown that the B. typhi abdominalis is much more sensitive than the B. coli to certain reagents, and that even the slight acid reaction of the potato retards its growth, whilst the B. coli grows luxuriantly. Nevertheless, our work would not have been complete in this direction unless we had by exact methods determined longevity of the typhoid bacillus in sewage and sewage effluents.

In these experiments partially sterilised and non-sterilised sewage and effluents have been used in order to see whether these fluids exerted a greater typhocidal action in the presence or absence of putrefactive bacteria.

A further reason for undertaking the investigation was that owing to the bile salt agar method a simpler means exists for the isolation and identification of this organism in sewage when present amongst overwhelming numbers of the ordinary putrefactive bacteria.

Methods.—Bile Salt Agar was chosen as the medium, because though it has a somewhat inhibiting effect upon B. typhosus yet it has at a temperature of 42° C. very marked power of preventing the growth of the more common organisms of the soil and water. Thus though it would not give the exact number of B. typhosus present yet by cutting out other organisms it would allow the use of lower dilutions; and by the characteristic reaction of B. coli a distinction could be made which would lessen the number of subcultures necessary.

The composition of bile salt agar has been detailed elsewhere, but to save the trouble of reference it may as well be given here.

Sodium Taurocholate (Ox bile)	0·5%
Peptone	2·0%
Agar	1·5%
Lactose	1·0%
Water	q.s.

The lactose is not added till after filtration, as overheating causes changes which spoil the medium.

The incubation temperature was always 42° C.; and the duration of incubation 48 hours.

Organisms producing acid from lactose cause a cloudiness in the medium round them. It is thus easy in most cases to separate the acid-producers from the non-acid producers. Some organisms (*e.g.*, Bacillus Capsulatus of Pfeiffer), however, when on the surface seem to produce acid at first and later alkali. Consequently the haze does not always appear round the surface colonies; but the majority of these colonies are distinguishable by their greater opacity. Again some organisms produce only a slight amount of acid from lactose in 48 hours, and have no visible haze round their colonies, but these are few in number, and do not mar the results to any great extent. As the B. typh. does not give rise to acid in a lactose medium it is easy to separate it and other similar organisms from the large number of acid-producers.

The plates were poured and incubated for 48 hours. Then the total number of colonies on the plates was counted, and from this was deducted the number of colonies which were obviously not B. typh., and thus an estimate was formed of the number of colonies which might be B.t.a. Cultures were made from the colonies in this latter group, and the organisms worked through the usual media and the percentage of B.t.a. cultures ascertained. From this percentage was calculated the number of B.t.a. in the liquid under examination. It may be said that this is a very inaccurate method, and that it is impossible to judge of the deep colonies from the results of the cultivation of those on the surface. Quite true, but considering the very large number of B.t.a. put into the various liquids and their enormous preponderance over the other organisms present, any error due to this method is an error on the right side, that is, the B.t.a. are, if anything, over and not under estimated. For the purpose of these experiments a slight over-estimation is of no importance, and is to a certain extent corrected by the inhibition due to the medium. Consequently we think that the results may be taken as fairly representing the conditions obtaining at the time the experiments were made.

The fluids used were obtained from Leeds, and were crude sewage; effluent from the open sewage tank; effluent from No. 2 Dibbin bed, and effluent from the Cameron bed.

The experiments may be divided into four series, series 3 and 4 being merely a repetition of Series 1 and 2, except that Cameron effluent was used instead of Dibdin effluent.

Series 1 and 3.—These experiments were to ascertain the effect upon the B.t.a. of the metabolic products of the organisms already growing in the liquid. For this purpose, as complete sterilization would have had a detrimental effect, about 600 c.c. of each liquid were placed in a wool stoppered flask, and the flask heated to 65° C. for from half to three-quarters of an hour. It was hoped by this means to kill most of the organisms present without destroying their products. When cool the flasks were inoculated with B.t.a. (Bac. typhi. abdominalis.)

Series 2 and 4.—These were to find out the effect of the crude liquids (*i.e.*, organisms and their products) upon the B.t.a. About 600 c.c. of each liquid were placed in a wool-stoppered flask and inoculated with B. t.a.

Plates were made from all the flasks just before inoculation to find out the number of organisms present.

Plates were also made directly after inoculation, so that the number of B.t.a. inoculated might be known.

The flasks were kept in a dark cupboard at room temperature, and plates were poured on several later dates and the numbers of B.t.a. present ascertained.

The numbers are the average of three plates, except in Series 1, before inoculation, when only one plate was poured from each flask.

The following contractions are used to indicate the various liquids:—

C.S.a.—Crude sewage partially sterilized by heating to 65° C.

O.S.T.a.—Open sewage tank effluent sterilized by heating to 65° C.

Dibdin a.—Dibdin bed No. 2 effluent sterilized by heating to 65° C.

Cameron a.—Cameron bed effluent sterilized by heating to 65° C.

C.S. b.—Crude sewage.

O.S.T.b.—Open sewage tank effluent.

Dibdin b.—Dibdin bed No. 2 effluent.

Cameron b.—Cameron bed effluent.

A small "1" placed after the letters indicates "before inoculation with B.t.a."

The organisms used for inoculation were:—

Series 1 and 2.—A B.t.a. obtained from Král.

Series 3 and 4.—A B.t.a. isolated by myself from the fœces in a case of enteric fever.

Both organisms were bacilli, actively motile whenever examined; they did not stain by Gram, they produced only acid in litmus glucose broth, either no change or decolorisation in litmus lactose broth, general

turbidity in ordinary broth, and no change or slight acid in litmus milk. On agar and gelatine they gave the usual growth of the B.t.a. Indol was sometimes produced and sometimes not. Both gave the serum reaction. Active motility was considered essential, and if in the subcultures an organism was not distinctly motile it was put down as doubtfully so, and therefore not B. typhosus.

1 c.c. of a 24 hours broth culture was put into each flask. The broth tube was not well shaken, and consequently some flasks received a larger number of organisms than others.

In Series 1 the partial sterilisation was most effective, as no colonies appeared on the plates made *after heating*, but *before inoculation*. The sterilisation was not complete, however, as extraneous organisms later made their appearance in gradually increasing numbers, and the condition approximated to those in the unheated flasks.

At first, as the flasks had been apparently sterile, only a single sub-culture was made, as it was thought only B.t.a. was present, but later, when it was obvious that there were other organisms, several subcultures were made. On some occasions the dilutions were too high, and there were only a few colonies on the plates, so many cultures could not be made.

In series 3 it was found that many organisms had resisted the heat applied. In this series the flasks were placed in a water bath kept at 67° C. No thermometer was put into the liquid in the flask, as was done in the case of the first series.

In these series also the dilutions were found to be occasionally too high.

Consequently, one cannot draw any *definite* conclusion as to the effect of the metabolic products alone upon the growth of the B.t.a.

Conclusions.

I.—Partially Sterilised Crude Sewage, inoculated with B. typhi abdominalis.

(a) That the organisms which have not been killed by the partial sterilization multiply and continue to do so for at any rate 17 days.

(b) That amongst these bacteria there is one which gives many of the reactions of the B.t.a., and might be confounded with it.

(c) That the B. typhosus does not multiply in this liquid, but gradually dies out, and that the duration of its life is greatly influenced by the presence of other organisms—the greater the number of the latter the shorter the time the B.t.a. remains alive.

II.—Crude Sewage, inoculated with B.t.a.

(a) That the total number of organisms gradually decreases.

(b) B. typhosus. In the first experiment, typhoid bacilli corresponding to the bacilli inoculated were recovered after 13 days; and these bacilli appeared to decrease at much the same rate as the other organisms. In the second experiment (the first examination after inoculation being made at the end of 6 days), though some 8,000,000 of B.t.a. per c.c. were inoculated, this organism was never recovered, nor was any organism resembling B.t.a. isolated, even though such an organism was present before inoculation. Thus in this case the B. typhosus must have died out rapidly. It may be concluded then, that the B.t.a. does not multiply, but dies more or less rapidly in crude sewage.

III.—Open Sewage Tank Effluent, partially sterilized, inoculated with B.t.a.

(a) That the organisms which have resisted the sterilization increase for a time, but soon begin to decrease.

(b) That the organism resembling B.t.a., which was isolated from crude sewage, is also present in this effluent.

(c) B. typhosus. In the first experiment this organism was recovered after 15 days, but in the second not after 10 days. That this bacillus does not multiply in this medium, but gradually dies out, the decrease in numbers proceeding at a more rapid rate than in the case of the other organisms in the later stages of the experiment.

(d) That this medium is less favourable than partially sterilized crude sewage to the growth of aerobic organisms in general, but the B. typhosus appears to be able to survive longer in it.

IV.—Open Sewage Tank Effluent.—Untreated.

(a) That the total number of organisms gradually decreases, and the medium is distinctly unfavourable to their growth.

(b) That the B.t.a. decreases at a rapid rate, but still survives longer in this medium than in crude sewage, having been recovered at the end of fifteen and seventeen days.

V.—Dibdin No. 2 Bed Effluent partially sterilized.

(a) That the total number of organisms gradually decreases.

(b) That the bacillus typhosus is capable of surviving as long in this medium as in open sewage tank effluent, having been recovered at the end of fifteen days.

VI.—Dibdin No. 2 Effluent.—Untreated.

(a) That a gradual decrease in the number of all organisms takes place.

(b) That the B. typhosus survives as long, but not in such numbers as it does in the partially sterilized effluent from this bed.

VII.—Cameron Bed Effluent, partially sterilized.

That the B. typhosus appears to die out more quickly in this effluent than in any of the fluids used.

There were 8,000,000 B. typhosus per c.c. at the commencement of the experiment, and these had decreased to less than 3,000 per c.c. in six days, and to less than 30 per c.c. in four days longer.

All organisms appeared to decrease rapidly.

VIII.—Cameron Bed Effluent.—Untreated.

Here again the conditions appear unfavourable to the growth of organisms.

The number of B. typhosus at the beginning of the experiment were some 12,000,000 per c.c., and yet none were recovered at the end of six days or later.

The total number of bacteria per c.c. was at the end of six days only some 7,000, four days later some 800, and seven days later had fallen to some 200 per c.c.

Thus this effluent seems to be much more highly purified than the Dibdin effluent.

As a final conclusion it may be stated that the fluids experimented with are inimical to the growth of the Bacillus typhosus, and if these pathogenic bacilli find their way into a bacteriological system of treatment they meet with conditions hostile to their multiplication.

We know that typhoid bacilli must find their way into the sewage from the excreta of persons suffering from typhoid, but they cannot be in large numbers, and in the various samples of crude sewage which we have examined we have not found any. Therefore it may be concluded that allowing that these bacilli do reach biological beds or septic tanks, they are present in such small numbers, and the conditions are so adverse to their existence, that they will not survive the treatment. But if from any cause they arrived to the beds or tanks in such large numbers as the B. coli, then certainly they might appear in the effluent just as the B. coli does. But, as in the case of the latter bacillus, so also in the case of the B. typhosus, there is no tendency to multiplication in the effluent.

November 1901.

A. MacCONKEY.

SERIES I.

CRUDE SEWAGE partially sterilized, heated to 65°C for half hour and inoculated with Bacillus Typhi Abdominalis.

C.S. (a).

—	2 April.	3 April.	9 April.	11 April.	15 April.	17 April.
1. Total number of - -	384,000 Dilution $\frac{1}{10,000}$ Average 38·4 per plate.	4,000 Dilution $\frac{1}{10,000}$ Average 0·4 per plate.	7,000 Dilution $\frac{1}{10,000}$ Average 0·7 per plate.	73,300 Dilution $\frac{1}{100}$ Average 733 per plate.	77,700 Dilution $\frac{1}{1,000}$ Average 77·7 per plate.	109,000 Dilution $\frac{1}{1,000}$ Average 109 per plate.
2. Number of organisms obviously not B. typhosus.	—	—	—	6,800	2,000	6,000
3. Number of organisms which might be B. typhosus.	384,000	4,000	7,000	66,500	75,700	103,000
4. Number of sub-cultures made from Group 3.	1 died before it could be worked out.	1	2	3	12	2
5. Percentage of Group 4, which on cultivation gave the reactions of B. typhosus.	—	100 per cent.	All re-actions except motility. Therefore not accepted as B.t.a.	33 per cent.	8 per cent.	100 per cent. gave all the re-actions except motility.
6. Number of B. typhosus per c.c.	—	4,000	—	22,000	6,300	—

REMARKS.

Series I.

C.S. (a) Partially Sterilized Crude Sewage.

As regards the total number of organisms there is an initial decrease and then a gradual increase.

As regards B. typh. there appears to be a large initial decrease, then a slight increase and then a decrease.

The heating obviously had not killed all the organisms present, but so few had escaped that their numbers may be neglected at first, and almost all the organisms present considered to be typhoid. This would give the initial number of B.t.a. as some 300,000 per c.c.

The countings of 3rd and 9th April cannot be taken into account as the dilution was too great, and there were too few colonies on the plates to allow an accurate estimate to be made. On the 11th April, *i.e.*, nine days after inoculation, the number of B.t.a. had decreased to 22,000 per c.c., while the extraneous organisms had increased to 51,000. On 15th April (13 days after inoculation), the B.t.a. numbered 6,300 per c.c., and the other organisms 71,400. On the 17th (15 days after inoculation), no B.t.a. were recovered.

Plates were also poured on 1st May (one month after inoculation). These plates had many colonies like B.c.c., and were crowded with very small opaque white colonies. There were a few colonies which somewhat resembled B.t.a. These latter were sub-cultured and found not to be B.t.a. Thus B. typh. was recovered from partially sterilized sewage 13 days after inoculation, but apparently it will not increase in such a medium.

At the end of one month the total numbers had fallen to some 3,000 B.c.c.-like organisms with others which were not B.t.a.

SERIES I.

Open Sewage Tank Effluent heated to 65° C. for half hour and inoculated with Bacillus Typhosus.

O.S.T. (a).

—	2 April.	3 April.	9 April.	11 April.	15 April.	17 April.
1. Total number of organisms per c.c.	354,000 Dilution $\frac{1}{10,000}$ Average 35·4 per plate.	270,000 Dilution $\frac{1}{10,000}$ Average 2·27 per plate.	264,000 Dilution $\frac{1}{10,000}$ Average 26·4 per plate.	160,000 Dilution $\frac{1}{10,000}$ Average 16 per plate.	87,000 Dilution $\frac{1}{10,000}$ Average 8·7 per plate.	45,400 Dilution $\frac{1}{1,000}$ Average 45·4 per plate.
2. Number of organisms obviously not B. typhosus.	—	—	—	—	24,000	21,700
. Number of organisms which might be B. typhosus.	354,000	270,000	264,000	160,000	63,000	23,700
4. Number of sub-cultures made from Group 3.	1	1	2	3	7	2
5. Percentage of Group 4 which on cultivation gave the reactions of B. typhosus.	100 per cent.	All re-actions except motility.	50 per cent.	66 per cent.	43 per cent. gave all re-actions except motility.	50 per cent.
6. Number of B. typhosus per c.c.	354,000	—	132,000	106,000	—	11,850

Remarks.

Series I.

O.S.T. (a). Partially Sterilised Open Sewage Tank Effluent.

Total number of Organisms :

Beginning of experiment - - - - - - - - 354,000 per c.c.
End of experiment (15 days later) - - - - - - 45,400 „
A gradual decrease took place throughout the duration of the experiment.
At the end of one month about - - - - - - - 47,000 „

Extraneous Organisms :

Did not make their appearance at first.

On the seventh day they had reached a total of some 130,000, and then they gradually decreased to some 34,000 on the 15th day of the experiment.

B.t.a. :

Initial number - - - - - - some 350,000 per c.c.
A gradual decrease to - - - - - „ 11,000 „ in 15 days.

Thus the B.t.a. have decreased at a more rapid rate than the other organisms. The latter after an initial increase soon decrease, and thus the medium appears to be less favourable to their growth than partially sterilized crude sewage in which they continued to increase.

B t.a. was not recovered from plates poured at the end of one month.

SERIES I.

DIBDIN, No. 2 Bed, Effluent, heated to 65° C. for half hour and inoculated with Bacillus Typhosus

D. (a).

—	2 April.	3 April.	9 April.	11 April.	15 April.	17 April.
1. Total number of organisms per c.c.	407,000 Dilution $\frac{1}{10,000}$ Average 40·7 per plate.	100,000 Dilution $\frac{1}{10,000}$ Average 10 per plate.	80,000 Dilution $\frac{1}{10,000}$ Average 8 per plate.	17,000 Dilution $\frac{1}{1,000}$ Average 17 per plate.	5,400 Dilution $\frac{1}{1,000}$ Average 5·4 per plate.	6,200 Dilution $\frac{1}{100}$ Average 62 per plate.
2. Number of organisms obviously not B. typhosus.	—	—	—	—	—	—
3. Number of organisms which might be B. typhosus.	407,000	100,000	80,000	17,000	5,400	6,200
4. Number of sub-cultures made from Group 3.	1 Died before it could be worked out.	1	2	2	4	2
5. Percentage of Group 4 which on cultivation gave the reactions of B. typhosus.		All reactions except motility.	100 per cent.	50 per cent.	100 per cent. gave all reactions except motility.	50 per cent.
6. Number of B. typhosus per c.c.			80,000	8,500		3,100

In this case only a small number of sub-cultures were done, because it was thought that only B.t.a. was present.

REMARKS.

Series I.

D. (a). Dibdin No. 2 Bed Effluent, partially sterilised.

Total Number of Organisms:

At beginning of experiment - - - - - - - -	407,000 per c.c.
At end of experiment (15 days) - - - - - - -	6,200 „
At end of one month - - - - - - - - - -	100 „

Extraneous Organisms:

The plates made before inoculation showed no growth, and throughout the experiment no obviously non-typhoid colonies appeared on the plates.

Sub-cultures, however, showed the presence of bacteria other than B.t.a., and the majority of these organisms differed from B.t.a. only in the amount of their motility. There was at first an increase and then a continued gradual decrease in their numbers.

B.t.a.:

Number at beginning of experiment - - - - -	some	400,000 per c.c.
Number at end - - - - - - - - - - -	„	3,000 „

The decrease is continued from the commencement of the experiment, and is more marked than in the case of similar Crude Sewage or Open Sewage Tank Effluent. This medium would therefore appear to be less favourable to the growth of B.t.a. than either similar Crude Sewage or Open Sewage Tank Effluent.

SERIES II.

CRUDE SEWAGE, inoculated with Bacillus Typhi Abdominalis.

C.S. (b).

—	2 April.	3 April.	9 April.	11 April.	15 April.	17 April.
1. Total number of organisms per c.c.	1,184,000 Dilution $\frac{1}{10,000}$ Average 118·4 per plate.	250,000 Dilution $\frac{1}{10,000}$ Average 25 per plate.	27,000 Dilution $\frac{1}{10,000}$ Average 2·7 per plate.	10,000 Dilution $\frac{1}{1,000}$ Average 10 per plate.	6,000 Dilution $\frac{1}{1,000}$ Average 6 per plate.	4,000 Dilution $\frac{1}{100}$ Average 40·4 per plate.
2. Number of organisms obviously not B. typhosus.	160,000	114,000	4,000	3,700	1,000	1,670
3. Number of organisms which might be B. typhosus.	1,024,000	136,000	23,000	6,300	5,000	2,370
4. Number of sub-cultures made from Group 3.	22 17 died before they could be worked out.	8	2	3 1 died before it could be worked out.	5	2
5. Percentage of Group 4 which on cultivation gave the reactions of B. typhosus.	20 per cent.	50 per cent.	All reactions, of B.t.a. except motility.	50 per cent.	20 per cent.	All reactions, except mo tility.
6. Number of B. typhosus per c.c.	205,000	68,000		1,850	1,000	

REMARKS.

Series II.

C.S. (b). Untreated Crude Sewage.

Total Number of Organisms :

There is a gradual decrease in number throughout the 15 days duration of the experiment from one million down to a few thousands.

Extraneous Organisms :

A gradual decrease from some 900,000 down to 5,000 per c.c.

B.t.a. :

A gradual decrease from some 200,000 down to 1,000 per c.c.

Thus the B.t.a. have decreased at about the same rate as the other organisms, and it cannot be said that Crude Sewage has any marked effect upon the growth of B.t.a., except that this organism has not shown any increase in this medium.

Plates were also poured on May 1st. (1 month after inoculation.) The total number of organisms was about 2,000 per c.c. No B.t.a. were recovered.

SERIES II.

Open Sewage Tank Effluent inoculated with Bacillus Typhosus.

O.S.T. (b).

	2 April.	3 April.	9 April.	11 April.	15 April.	17 April.
1. Total number of organisms per c.c.	117,000 Dilution $\frac{1}{10,000}$ Average 11·7 per plate.	234,000 Dilution $\frac{1}{10,000}$ Average 23·4 per plate.	60,000 Dilution $\frac{1}{10,000}$ Average 6 per plate.	22,400 Dilution $\frac{1}{1,000}$ Average 22·4 per plate.	2,700 Dilution $\frac{1}{1,000}$ Average 2·7 per plate.	2,400 Dilution $\frac{1}{100}$ Average 23·7 per plate.
2. Number of organisms obviously not B. typhosus.	—	14,000	4,000	2,000	1,000	400
3. Number of organisms which might be B. typhosus.	117,000	220,000	56,000	20,000	1,700	2,000
4. Number of sub-cultures made from Group 3.	5 2 died before they could be worked out.	9	2	9	7	2
5. Percentage of Group 4 which on cultivation gave the reactions of B. typhosus.	66 per cent. gave all reactions except motility.	66 per cent.	50 per cent.	56 per cent.	100 per cent. gave all reactions except motility.	50 per cent.
6. Number of B. typhosus per c.c.	—	146,000	23,000	11,400	—	1,000

Remarks.

Series II.

O.S.T. (b). Open Sewage Tank Effluent.

Total number of organisms:

Initial number	some	117,000 per c.c.
After 24 hours	„	234,000 „
After 7 days	„	60,000 „
After 15 days	„	2,400 „
After 1 month	„	200 „

Extraneous organisms:

At the end of 24 hours they had reached a total of 88,000 per c.c. There was apparently no further increas but a gradual decrease to some 1,400 per c.c. in 15 days.

B.t.a.:

The initial number was doubtful. A large number of B.t.a. was inoculated, and yet on cultivation none of the organisms isolated from the plates gave all the reactions of the B. typhosus. The motility was not sufficiently marked. At the end of 24 hours the B.t.a. numbered 146,000 per c.c., and then a decrease took place until at the end of 15 days there were only 1,000 per c.c. Thus they decreased at about the same rate as the other bacteria, and it cannot be said that the presence of the other organisms had any marked effect upon the growth of B.t.a.

The B. typhosus seems to live in open sewage tank effluent much as it does in crude sewage.

SERIES II.

D. (b).

Dibdin, No 2 Bed, Effluent inoculated with Bacillus Typhosus.

——	2 April.	3 April.	9 April.	11 April.	15 April.	17 April.
1. Total number of organisms per c.c.	204,000 Dilution $\frac{1}{10,000}$ Average 20·4 per plate.	420,000 Dilution $\frac{1}{10,000}$ Average 42 per plate.	3,000 Dilution $\frac{1}{10,000}$ All the 3 plates sterile.	770 Dilution $\frac{1}{100}$ Average 7·7 per plate.	346 Dilution $\frac{1}{100}$ Average 3·4 per plate.	214 Dilution $\frac{1}{10}$ Average 31·4 per plate.
2. Number of organisms obviously not B. typhosus.	—	—	—	100	70	64
3. Number of organisms which might be B. typhosus.	204,000	420,000	3,000	670	270	150
4. Number of sub-cultures made from Group 3.	5 3 died before they could be worked out.	10	None.	4	3	2
5. Percentage of Group 4 which on cultivation gave tbe reactions of B. typhosus.	50 per cent.	70 per cent.	—	25 per cent.	66 per cent. gave all reactions of B.t.a. except motility.	50 per cent.
6. Number of B. typhosus per c.c.	102,000	294,000	—	170	—	75

Remarks.

Series II.

D. (b). Untreated Effluent from Dibdin, No. 2. Bed.

Total number of organisms :

At beginning of experiment - - - - - - -	204,000	per c.c.
At end of 24 hours - - - - - - - - -	420,000	„
At end of 15 days - - - - - - - - -	214	„
At end of 1 month - - - - - - - - -	20	„

Extraneous organisms :

Initial number - - - - - - - - -	some	102,000	per c.c.
After 24 hours - - - - - - - - -	„	126,000	„
After nine days - - - - - - - - -	„	600	„
After 15 days - - - - - - - - -	„	130	„
After 1 month - - - - - - - - -	„	20	„

B.t.a. :

At beginning of experiment - - - - - - -	102,000	per c.c.
At end of 24 hours - - - - - - - -	294,000	„
At end of 9 days - - - - - - - - - -	170	„
At end of 15 days - - - - - - - - -	75	„

The diminution in the number both of B.t.a. and other organisms is much more marked than in any of the other liquids used in this series, and it appears that even merely partial sterilisation renders this medium more favourable to the longevity of B.t.a.

APRIL 2ND.

Number of Culture and Source.	Description.	Gram.	Indol.	Broth.	Litmus Glucose Broth.	Litmus Lactose Broth.	Litmus Milk.
C.S. (a) -	- - - -	—	—	—	A.	—	—
O.S.T. (a) -	Actively motile bacillus	—	—	G.T.	,,	No Ch.	A.
D. (a) -	- - -	—	—	—	,,	—	—
C.S. (b) 3 -	? motile bacillus -	—	—	G.T.	,,	No Ch.	A.
17	Active bacillus - -	—	—	,,	,,	,,	,,
18	Slightly motile bacillus -	—	—	,,	,,	,,	,,
19 -	? ,, ,, -	—	—	,,	,,	,,	,,
22 -	Slightly ,, ,, -	—	—	,,	,,	,,	,,
Other Cultures from 1 to 22.	- - - -	—	—	—	,,	—	—
O.S.T. (b) 1 -	- - - -	—	—	—	,,	—	—
2 -	- - - -	—	—	—	,,	—	—
3 -	Slightly motile bacillus -	—	—	G.T.	,,	No Ch.	A.
4 -	Actively ,, ,, -	—	—	,,	A.	A.	A. + Clct.
5 -	Motile bacillus - -	—	—	,,	A.	No Ch.	A.
D. (b) 1 -	- - - -	—	—	—	,,	—	—
2 -	Actively motile bacillus -	—	—	G.T.	,,	No Ch.	A.
3 -	Motile bacillus - -	—	—	,,	,,	,,	,,
4 -	- - - -	—	—	—	,,	—	—
5 -	- - - -	—	—	—	,,	—	—

The cultures were made from the plates into Bile Salt Glucose broth just before Easter. When after Easter further sub-cultures were made it was found that most of the organisms had died. All, except one, gave only acid with glucose.

Those that lived were non-liquefiers and gave the ordinary growths on Agar and Gelatine, and, with the exception in some cases of their motility, corresponded to the B. typhosus which had been used for the inoculation.

Counting only actively motile organisms, then :—
O.S.T. (a) 100 per cent. were B.t.a.
C.S. (b) 20 ,, ,,
O.S.T. (b) none ,,
D. (b) 50 per cent. ,,

A. = Acid.
G. = Gas.
D. = Decolorization.
G.T. = General Turbidity.
C. = Clotting.
No Ch. = No Change.

April 3rd.

Number of Culture and Source.	Description.	Gram.	Indol.	Broth.	Litmus Glucose Broth.	Litmus Lactose Broth.	Litmus Milk.
C.S. (a) - -	Actively motile bacillus-	—	—	G.T.	A.	D.	A.
O.S.T. (a) - -	Slightly " " -	—	—	"	"	S. D.	"
D. (a) - -	" " " -	—	—	"	"	No Ch.	"
C.S. (b) 1 -	Not B.t.a. - - -	—	—	"	A. & G.	"	"
2 -	" - - -	—	—	"	"	"	"
3 -	Slightly motile bacillus-	—	—	"	A.	S. D.	"
4 -	Actively " " -	—	—	"	"	"	"
5 -	? " " -	—	—	"	"	"	"
6 -	Active bacillus - -	—	—	"	"	"	"
7 -	" " - -	—	—	"	"	"	"
8 -	" " - -	—	—	"	"	No Ch.	? "
O.S.T. (b) 1 -	Actively motile bacillus-	—	—	"	"	D.	"
2 -	Slightly " " -	—	—	"	"	"	"
3 -	Actively " " -	—	—	"	"	"	"
4 -	" " " -	—	—	"	"	"	"
5 -	" " " -	—	—	"	"	"	"
6 -	" " " -	—	—	"	"	"	"
7 -	Slightly " " -	—	—	"	"	"	"
8 -	? " " -	—	—	"	"	"	"
9 -	Actively " " -	—	—	"	"	"	"
D. (b) 1 -	" " " -	—	—	"	"	"	"
2 -	" " " -	—	—	"	"	"	"
These were all the surface colonies on one plate. 3 -	" " " -	—	—	"	"	"	"
4 -	" " " -	—	—	"	"	"	"
5 -	Slightly " " -	—	—	"	"	"	"
6 -	" " " -	—	—	"	"	"	"
7 -	Actively " " -	—	—	"	"	"	"
8 -	" " " -	—	—	"	"	"	"
9 -	" " " -	—	—	"	"	"	"
10 -	Slightly " " -	—	—	"	"	"	"

These organisms were all non-liquefiers, and gave ordinary growths on agar and gelatine.

Percentage of cultures corresponding to bac. innoculated :

C.S. (a) - - -	100 per cent.	C.S. (b) - - -	50 per cent.
O.S.T. (a) - - -	? 0	O.S.T. (b) - - -	66 "
D. (a) - - -	? 0	D. (b) - - -	70 "

A. = Acid.
G. = Gas.
D. = Decolorization
S.D. = Slight "

G.T. = General Turbidity.
No Ch. = No Change.
C. = Coagulation.

APRIL 9TH.

Number of Culture and Source.	Description.	Gram.	Indol.	Broth.	Litmus Glucose Broth.	Litmus Lactose Broth.	Litmus Milk.
C.S. (a) 1 -	? motile bacillus -	—	—	G.T.	A.	No Ch.	A.
2 -	? ,, ,, -	—	—	,,	,,		,,
O.S.T. (a) 1 -	? ,, ,, -	—	—	,	A. & G.	A. & G.	A. & Clot.
2 -	Actively ,, ,, -	—	—	,	A.	Decol.	A.
D. (a) 1 -	,, , , -	—	—	,,	,,		
2 -	,, ,, -	—	—	,	,,	,,	,,
C.S. (b) 1 -	Slightly ,, ,, -	—	—		,,	No Ch.	,,
2 -	,, , ,, -	—	—		,,	A.	
O.S.T. (b) 1 -	Actively ,, ,, -	—	—	,	,,	Decol.	,
2 -	,, ,, ,, -	—	—	,	A. & G.	A. & G.	A. & Clot.

These organisms were all non-liquefiers, and gave ordinary growths on agar and gelatine.

Percentage of cultures like B.t.a. :—

C.S. (a) - - - - - - - - None.
O.S.T. (a) - - - - - - - - 50 per cent.
D. (a) - - - - - - - - 100 ,,
C.S. (b) - - - - - - - - None.
O.S.T. (b) - - - - - - - - 50 per cent.

A. = Acid.
G. = Gas.
C. = Coagulation.

G.T. = General Turbidity
No Ch. = No Change.
D. = Decolorization.

APRIL 11TH.

Number of Culture and Source.	Description.	Gram.	Indol.	Broth.	Litmus Glucose Broth.	Litmus Lactose Broth.	Litmus Milk.
C.S. (a) 1 -	Actively motile bacillus	—	—	G.T.	A.	No Ch.	A.
2 -	Slightly " " -	—	—	"	"	"	No Ch.
3 -	" " " -	—	—	"	"	"	A.
O.S.T. (a) 1 -	" " " -	—	—	"	A. & G.	A. & G.	"
2 -	Actively " " -	—	—	"	A.	Decol.	"
3 -	" " " -	—	—	"	"	"	"
D. (a) 1 -	" " " -	—	—	"	"	"	"
2 -	Slightly " " -	—	—	"	No Ch.	No Ch.	No Ch.
C.S. (b) 1 -	Motile " -	—	—	"	A. & G.	A. & G.	A
2 -	Died - - - -	—	—	"	A.	No Ch.	"
3 -	Actively motile bacillus	—	—	"	"	Decol.	"
O.S.T. (b) 1 -	" " " -	—	—	"	"	"	"
These were 2 -	Slightly " " -	—	—	"	"	"	"
all the 3 -	Actively " " -	—	—	"	"	No Ch.	No Ch.
surface colonies 4 -	" " " -	—	—	"	"	Decol.	A.
on the 3 plates. 5 -	Slightly " " -	—	—	"	"	"	"
6 -	Actively " " -	—	—	"	"	"	"
7 -	" " " -	—	—	"	"	"	"
8 -	Slightly " " -	—	—	"	"	"	"
9 -	Actively " " -	—	—	"	"	"	"
D (b) 1 -	Slightly " " -	—	—	"	"	"	"
2 -	Actively " " -	—	—	"	"	"	"
3 -	Slightly " " -	—	—	"	"	No Ch.	"
4 -	" " " -	—	—	"	"	"	"

O.S.T. (b) 3 was a liquefier. All the rest were non-liquefiers, and gave ordinary growths on agar and gelatine.

Percentage of culture-like B.t.a. :—

C.S. (a) - - - - - - - - -	33 per cent.
O.S.T. (a) - - - - - - - - -	66 "
D. (a) - - - - - - - - -	50 "
C.S (b) - - - - - - - - -	50 "
O.S.T. (b) - - - - - - - - -	56 "
D. (b) - - - - - - - - -	25 "

A. = Acid.
G. = Gas.
C. = Coagulation.

Decol. = Decolorization.
No Ch. = No change.
G.T. = General turbidity.

APRIL 15TH.

Number of Culture and Source.		Description.	Gram.	Indol.	Broth.	Litmus Glucose Broth.	Litmus Lactose Broth.	Litmus Milk.
C.S. (a)	1 -	Slightly motile bacillus -	—	—	G.T.	A.	No Ch.	A.
	2 -	? ,, ,, -	—	—	,,	,,	,,	,,
These were	3 -	,, ,, ,, -	—	—	,,	,,	,,	,,
all the surface	4 -	Actively ,, ,, -	—	—	,,	,,	,,	No Ch. or very slight A.
colonies on the	5 -	? ,, ,, -	—	—	,,	,,	,,	A.
3 plates.	6 -	,, ,, ,, -	—	—	,,	,,	,,	No Ch.
	7 -	,, ,, ,, -	—	—	,,	,,	Decol.	A.
	8 -	,, ,, ,, -	—	—	,,	,,	No Ch.	,,
	9 -	,, ,, ,, -	—	—	,,	,,	,,	,,
	10 -	,, ,, ,, -	—	—	,,	,,	,,	,,
	11 -	,, ,, ,, -	—	—	,,	,,	,,	,,
	12 -	,, ,, ,, -	—	—	,,	,,	,,	,,
O.S.T. (a)	1 -	Slightly ,, ,, -	—	—	,,	A. & G.	A.	,,
	2 -	,, ,, ,, -	—	—	,,	A.	,,	,,
	3 -	? ,, ,, -	—	—	,,	A. & G.	A. & G.	,,
	4 -	? ,, ,, -	—	—	,,	,,	,,	,,
	5 -	? ,, ,, -	—	—		A.	No Ch.	,,
	6 -	? ,, ,, -	—	—	,,	,,	Decol.	,,
	7 -	? ,, ,, -	—	—	,,	A. & G.	A. & G.	,,
D. (a)	1 -	,, ,, ,, -	—	—	,,	A.	No Ch.	,,
	2 -	,, ,, ,, -	—	—	,,	,,	Decol.	,,
	3 -	Slightly ,, ,, -	—	—	,,	,,	,,	,,
	4 -	? ,, ,, -	—	—	,,	,,	,,	,,
C.S. (b)	1 -	,, ,, ,, -	—	—	,,	A. & G.	,,	,,
	2 -	Actively ,, ,,	—	—	,,	A.	,,	,,
	3 -	Motile ,, -	—	—	,,	,,	,	,,
	4 -	? ,, ,, -	—	—	,,	,,	,,	,,
	5 -	Actively ,, ,, -	—	—	,,	A. & G.	No Ch.	No Ch. or slight A.
O.S.T. (b)	1 -	Motile ,, -	—	—	,,	A.	Decol.	A.
	2 -	? ,, ,, -	—	—	,,	,,	No Ch.	,,
	3 -	? ,, ,, -	—	—	,,	,,	Decol.	,,
D. (b)	1 -	? ,, ,, -	—	—	,,	No Ch.	No Ch.	Decol.
	2 -	? ,, , -	—	—	,,	A.	Decol.	A.
	3 -	? ,, ,, -	—	—	,,	,,	,,	,,

All were non-liquefiers and gave ordinary growths on agar and gelatine.

Percentage of culture like B.t.a. :—

C.S. (a) - -	- 8 per cent.	C.S. (b) - -	- 20 per cent.
O.S.T. (a) - -	- none.	O.S.T. (b) - -	- none.
D. (a) - -	- none.	D. (b) - -	- none.

A.=Acid. G.=Gas. C.=Coagulation. Decol.=Decolorization. No Ch.=No Change. G.T.=General Turbidity.

APRIL 17TH.

Number of Culture and Source.	Description.	Gram.	Indol.	Broth.	Litmus Glucose Broth.	Litmus Lactose Broth.	Litmus Milk.
C.S. (a) 1 - Taken off for B.c.c.	Slightly motile bacillus -	—	—	G.T.	A. & G.	A. & G.	A. & G.
2 -	" " " -	—	—	"	A.	No Ch.	A.
3 -	" " " -	—	—	"	"	"	"
4 -	" " " -	—	—	"	"	"	"
O.S.T. (a) 1 -	" " " -	—	—	"	A. & G.	A.	"
2 -	Actively " " -	—	—	"	A.	Decol.	"
D. (a) 1 -	Slightly " " -	—	—	"	"	"	"
2 -	Actively " " -	—	—	"	"	"	"
C.S. (b) 1 -	Slightly " " -	—	—	"	"	No Ch.	"
2 -	" " " -	—	—	"	"	Decol.	"
O.S.T. (b) 1 -	" " " -	—	—	"	"	"	"
2 -	Actively " " -	—	—	"	"	No Ch.	"
O. (b) 1 -	Slightly " " -	—	—	"	"	Decol.	"
2 -	Actively " " -	—	—	"	"	"	"

All were non-liquefiers and gave ordinary growths on agar and gelatine.

C.S. (a) 1 was cultured as a recognised B.c.c. A culture was heated to 65° C. for half-hour and was found to be killed.

C.S. (a) - - -	none.	C.S. (b) - - -	none.
O.S.T. (a) - - -	50 per cent.	O.S.T. (b) - - -	50 per cent.
D. (a) - - -	50 "	D. (b) - - -	50 "

A. = Acid. C. = Coagulation. Decol. = Decolorization. G. = Gas.
No Ch. = No Change. G.T. = General Turbidity.

May 1st.

Source and Number.	Organism.	Motility.	Broth.	Litmus Glucose Broth.	Litmus Lactose Broth.	Litmus Milk.	Gelatine Slant or Stab.	Agar.	Gram.
C.S. (a) 1	Bacillus -	Active -	G.T.	No Ch.	No Ch.	No Ch. or slight Alk.	White	Whitish	—
2	,,	Slight -	,,	A.	,,	A.	,,	,,	—
3	,,	Active -	,,	No Ch.	,,	Alk. - -	,,	,,	—
C.S. (b) 1	,,	,,	,,	A. & G.	A. & G.	A.			
2	,,	,,	,,	,,	,,	A. & C.			
3	,,	,,	,,	,,	,,	A.			
4	,,	,,	,,	No Ch.	No Ch.	No Ch. or slightly Alk.	Orange (late)	,,	—
5	,,	,,	,,	A. & G.	A. & G.	A. & C.			
O.S.T. (a) 1	,,	Slight -	,,	,,	A.	A.			
2	,,	?	,,	No Ch.	No Ch.	Alk. - -	Greyish	,,	—
3	,,	?	,,	A. & G.	A.	A.			
4	,,	?	,,	No Ch.	No Ch.	No Ch. or slight Alk.	,,	,,	—
5	,,	?	,,	A. & G.	A.	A.			
O.S.T. (b) 1	No growth								
2	Bacillus -	?	,,	No Ch.	No Ch.	No Ch. or slight Alk.	,,	,,	—
3	No growth								
4	,,								
D. (a) 1	Bacillus -	?	,,						
2	,,	?	,,	No Ch.	,,	Alk. - -	White	,,	—
3	,,	Slight -	,,	A.	,,	A.	,,	,,	—
D. (b) 1	,,	Active -	,,	A. & G.	A. & G.	A. & C.			
2	,,	,,	,,	No Ch.	No Ch.	Alk. - -	Greyish	Greyish	—
3	,,	,,	,,	A. & G.					
4	,,	Slow -	,,	,,					

SERIES III.

CRUDE SEWAGE heated for half to three-quarter hours at about 65° C.

C.S. (a).

—	8 May.	14 May.	18 May.	25 May.
1. Number of organisms before inoculation per c.c.	50 B.c.c.-like - - - 11 B.t.a.-like numerous minute white colonies.	Plated un-diluted.		
2. Number after inoculation per c.c.	3,200,000 Dilution $\frac{1}{10,000}$ Average 320 per plate.	640,000 Dilution $\frac{1}{10,000}$ Average 64 per plate.	1,534,000 Dilution $\frac{1}{10,000}$ Average 153·4 per plate.	1,617,000 Dilution $\frac{1}{10,000}$ Average 161·7 per plate.
3. Number which were obviously not B. typhosus.	—	434,000	344,000	204,000
4. Number which might be B. typhosus.	Some 3,000,000	206,000	1,190,000	1,413,000
5. Number of cultures made from Group 6.	3	6	8	6
6. Percentage of cultures (5) which correspond to B. typhosus.	100 per cent.	66 per cent.		
7. Number of B. typhosus per c.c.	About 3,000,000	About 131,000		

REMARKS.

Series III.

C.S. (a). Partially sterilized Crude Sewage.

Total Number of Organisms per c.c.:

At beginning of experiment	3,200,000	per c.c.
After 6 days	640,000	„
„ 10 „	1,534,000	„
„ 17 „	1,617,000	„

No. of Extraneous organisms:

At beginning of experiment	about	200	„
After 6 days		509,000	„
„ 10 „	apparently	1,500,000	„
„ 17 „	„	1,600,000	„

B.t.a.:

At beginning of experiment	some	3,000,000	„
After 6 days	„	130,000	„
„ 10 „	not recovered.		
„ 17 „	„	„	

This experiment confirms the similar one in Series I. The B.t.a. gradually decrease (in this case much more quickly than before), while the other organisms continue to increase.

It will be seen by referring to the table of Cultures made on May 8th (the first day of experiment) that there was present in the sewage an organism very like B.t.a. except in its motility.

SERIES III.

OPEN SEWAGE TANK EFFLUENT heated half to three-quarter hours at 65° C.

O.S.T. (a).

—	8 May.	14 May.	18 May.	25 May.
Number of organisms before inoculation.	3 B.c.c.-like. Plated undiluted.	—	—	—
Number after inoculation -	1,734,000 Dilution $\frac{1}{10,000}$ 173·4 per plate.	474,000 Dilution $\frac{1}{10,000}$ 47·4 per plate.	1,220,000 Dilution $\frac{1}{10,000}$ 122 per plate.	274,000 Dilution $\frac{1}{10,000}$ 27·4 per plate.
Number which were obviously not B. typhosus.	—	—	7,000	—
Number which might be B. typhosus.	1,734,000	474,000	1,213,000	274,000
Number of cultures made from Group 4.	3	6 All the surface colonies on one plate.	5	6
Percentage of cultures (5) which correspond to B. typhosus.	100 per cent.	100 per cent.	20 per cent.	—
Number of B. typhosus per c.c.	About 1,700,000	About 470,000	About 240,000	—

REMARKS.

Series III.

O.S.T. (a). Partially sterilized Open Sewage Tank Effluent.

otal number per c.c. :

At beginning of experiment	-	1,700,000 per c.c.
After 6 days	-	474,000 „ „
„ 10 „	-	1,220,000 „ „
„ 17 „	-	1,274,000 „ „

xtraneous organisms :

At beginning of experiment	-	3 per c.c
After 10 days	-	980,000 „ „
„ 17 „	-	270,000 „ „

The few organisms, other than B.t.a., which were present at the commencement of the experiment increased to
out 1 million per c.c., and then began to decrease.

t.a. :

At beginning of experiment	-	1,700,000 per c.c.
After 6 days	-	470,000 „ „
„ 10 „	-	240.000 „ „
„ 17 „	-	not recovered

Thus the B. typhosus does not increase but steadily decreases in this medium.

SERIES III.

CAMERON BED EFFLUENT heated from half to three-quarters of an hour.

Cameron (a).

——	8 May.	14 May.	18 May.	25 May.
1. Number of organisms before inoculation.	Apparently sterile. Plated undiluted.	—	—	—
2. Number after inoculation -	8,800,000 Dilution $\frac{1}{10,000}$ 880 per plate.	Dilution $\frac{1}{10,000}$ too great, no growth on plates.	Dilution $\frac{1}{100}$ too great, no growth on plates.	Undiluted. No growth on plates.
3. Number which were obviously not B. typhosus.	—	—	—	—
4. Number which might be B. typhosus.	8,800,000	—	—	—
5. Number of cultures made from Group 4.	3	—	—	—
6. Percentage of cultures (5) which correspond to B. typhosus.	100 per cent.	—	—	—
7. Number of B. typhosus per c.c.	About 8,500,000	Less than 3,300	Less than 33	—

REMARKS.

Series III.

Cameron (a). Partially Sterilized Cameron Bed Effluent.

Total number of organisms:

At beginning of experiment - - - - - - - 8,800,000 per c.c.

These were apparently almost all B.t.a.

The decrease in numbers in this medium is most marked.

No extraneous organisms made their appearance, which is in marked contrast to the other liquids of this series.

SERIES IV.

CRUDE SEWAGE, Untreated.

C.D. (b).

—	8 May,	14 May.	8 May.	25 May.
. Number of organisms before inoculation.	170,000 127,000 B.cc.-like. 43,000 B.t.a.-like. Plated $\frac{1}{10,000}$ 17 per plate.	—	—	—
2. Number after inoculation -	9,280,000 Dilution $\frac{1}{10,000}$ 928 per plate.	274,000 Dilution $\frac{1}{10,000}$ 27·4 per plate.	94,000 Dilution $\frac{1}{10,000}$ 9·4 per plate.	34,700 Dilution $\frac{1}{1,000}$ 34·7 per plate.
3. Number which were obviously not B. typhosus.	330,000	180,000	57,000	12,000
. Number which might be B. typhosus.	8,950,000	94,000	37,000	22,700
5. Number of cultures made from Group 4.	5	6	5	4
6. Percentage of cultures (5) which correspond to B. typhosus.	100 per cent.	—	—	—
7. Number of B. typhosus per c.c.	about 8,500,000	—	—	—

REMARKS.

Series IV. C.S. (b). Untreated Crude Sewage.

Total number of organisms :

At beginning of experiment - - - - - -		9,000,000 per c.c.
After 6 days - - - - - - - - - -		274,000 „
„ 10 „ - - - - - - - - - -		94,000 „
„ 17 „ - - - - - - - - - -		34,000 „

Extraneous organisms :

At beginning of experiment - - - - - -		170,000 per c.c.
After 6 days - - - - - - -	apparently	270,000 „
„ 10 „ - - - - - - -	„	94,000 „
„ 17 „ - - - - - - -	„	34,000 „

B.t.a. :

At commencement of experiment - - - - - - 8,500,000 per c.c.
Not recovered on 6th day or later.

It must be concluded then that this sample of Crude Sewage was not favourable to the growth of B.t.a.

Here again [as in C.S. (a)] an organism which resembled B.t.a. was recovered from the Sewage before inoculation.

SERIES IV.

OPEN SEWAGE TANK EFFLUENT, Untreated.

O.S.T. (b).

——	8 May.	14 May.	18 May.	25 May.
1. Number of organisms before inoculation.	24,000 20,000 B.c.c.-like. 4,000 B.t.a.-like. Plated $\frac{1}{10,000}$			
2. Number after inoculation -	24,000,000 Dilution $\frac{1}{10,000}$ about 2,400 per plate.	34,000 Dilution $\frac{1}{10,000}$ 3·4 per plate.	5,400 Dilution $\frac{1}{1,000}$ 5·4 per plate.	2,870 Dilution $\frac{1}{100}$ 28·7 per plate.
3. Number which were obviously not B. typhosus.	14,000	—	3,000	270
4. Number which might be B. typhosus.	23,086,000	34,000	2,400	2,600
5. Number of cultures made from Group 4.	5	5 All from the same plate.	4	4
6. Percentage of cultures (5) which correspond to B. typhosus.	100 per cent.	100 per cent.	100 per cent.	25 per cent.
7. Number of B. typhosus per c.c.	About 23,000,000	About 30,000	About 2,000	About 600

REMARKS.

Series IV. O.S.T. (b). Untreated Open Sewage Tank Effluent.

Total number of organisms :

At beginning of experiment	- - - - - - - -	24,000,000 per c.c.
After 6 days	- - - - - - - - - - -	34,000 ,,
,, 10 ,,	- - - - - - - - - - -	5,400 ,,
,, 17 ,,	- - - - - - - - - - -	2,800 ,,

Extraneous organisms :

At beginning of experiment	- - - -	24,000 per c.c.
After 6 days	- - - - - - - -	?
,, 10 ,,	- - - - - - - - - - -	3,000 ,,
,, 17 ,,	- - - - - - - - - - -	2,000 ,,

B.t.a. :

At beginning of experiment	- - - -	23,000,000 per c.c.
After 6 days	- - - - - - - - - - -	30,000 ,,
,, 10 ,,	- - - - - - - - - - -	2,000 ,,
,, 17 ,,	- - - - - - - - - - -	600 ,,

There is a general decrease in total numbers of organisms, but more especially in the case of B.t.a.

From this liquid before inoculation there was obtained a Bacillus resembling B.t.a. in most particulars. It was not present in great numbers, at most 2,000 per c.c., and therefore it could not affect the initial number of B.t.a. If it has been included in the later numbers, it only makes the decrease in the number of B. typhosus more marked.

SERIES IV.

Cameron (b).

CAMERON BED EFFLUENT Untreated.

	8 May.	14 May.	18 May.	25 May.
1. Total number of organisms before inoculation.	About 6,000. B.t.a.-like. Plated 1/10,000			
2. Total number of organisms after inoculation.	16,000,000 Dilution 1/10,000 About 1,600 per plate.	6,700 Dilution 1/10,000 Too great, only two colonies on three plates.	840 Dilution 1/100 8·4 per plate.	189 Undiluted. 189 per plate.
3. Number of organisms obviously not B. typhosus.	—	3,400	670	101
4. Number of organisms which might be B. typhosus.	16,000,000	3,300	170	88
5. Number of cultures made from Group 4.	5	1	5	7
6. Percentage of cultures (5) which correspond to B. typhosus.	80 per cent.	—	—	—
7. Number of B. typhosus per c.c.	About 12,000,000.	—	—	—

REMARKS.

Series IV.

Cameron (b). Untreated Cameron Bed Effluent.

Total number of organisms :

At beginning of experiment	16,000,000	per c.c.
After 6 days	6,700	„
„ 10 „	840	„
„ 17 „	189	„

Extraneous organisms :

At commencement of experiment	4,000	per c.c.
After 6 days - apparently	6,700	„

and later, same as total number.

B.t.a. :

At commencement of experiment - - - - - - 12,000.000 per c.c.

No B.t.a. were recovered subsequently.

The decrease in all organisms is marked, but especially in the case of B.t.a.

8 May 1901.

Source and Number.	Organism.	Motility.	Broth.	Litmus Glucose Broth.	Litmus Lactose Broth.	Litmus Milk.	Gelatine, Slant or Stab.	Agar.	Gram.
C.S. $(a)_1$ 1 -	Bacillus	?	G.T.	A.	N. Ch.	A.	White, translucent	Moist, whitish.	—
2 -	No growth.								
3 -	Bacillus	?	„	A. and G.	A. and G.	A. and C.	„ „	„ „	—
C.S. $(a)_2$ 1 -	„	Active	„	A.	N. Ch.	A.	„ „	„ „	—
2 -	„	„	„	„	Decol.	„	„ „	„ „	—
3 -	„	„	„	„	N. Ch.	„	„ „	„ „	—
C.S. $(b)_1$ 1 -	? Coccus	–	Slight granular, G.T.	„	A.	A. and C.	Scanty growth of small transparent colons.	Scanty grey transparent.	+
2 -	Bacillus	Motile	G.T.	N. Ch.	N. Ch.	Alk.	White, translucent	Moist, whitish.	—
3 -	„	?	„	A.	„	A.	„ „	„ „	—
4 -	„	?	„	A. and G.	„	„	„ „	„ „	—
5 -	„	?	„	„	„	„	„ „	„ „	—
C.S. $(b)_2$ 1 -	„	Active	„	A.	„	„	„ „	„ „	—
2 -	„	„	„	„	Decol.	„	„ „	„ „	—
3 -	„	„	„	„	N. Ch.	„	„ „	„ „	—
4 -	„	„	„	„	Decol.	„	„ „	„ „	—
5 -	„	„	„	„	„	„	„ „	„ „	—
O.S.T. $(a)_2$ 1 -	„	„	„	„	N. Ch.	„	„ „	„ „	—
2 -	„	„	„	„	Decol.	„	„ „	„ „	—
3 -	„	„	„	„	N. Ch.	„	„ „	„ „	—
O.S.T. $(b)_1$ 1 -	„	„	„	„	„	„	„ „	„ „	—
2 -	„	?	„	„	„	„	„ „	„ „	—
O.S.T. $(b)_2$ 1 -	„	Active	„	„	„	„	„ „	„ „	—
2 -	„	„	„	„	„	„	„ „	„ „	—
3 -	„	„	„	„	Decol.	„	„ „	„ „	—
4 -	„	„	„	„	„	„	„ „	„ „	—
5 -	„	„	„	„	„	„	„ „	„ „	—
Cam. $(a)_2$ 1 -	„	„	„	„	N. Ch.	„	„ „	„ „	—
2 -	„	„	„	„	Decol.	„	„ „	„ „	—
3 -	„	„	„	„	N. Ch.	„	„ „	„ „	—
Cam $(b)_1$ 1	„	Motile	„	„	„	„	„ „	„ „	—
Cam $(b)_2$ 1 -	„	?	„	A. and G.	A. and G.	A. and C.	„ „	„ „	—
2 -	„	Active	„	A.	N. Ch.	A.	„ „	„ „	—
3 -	„	„	„	„	„	„	„ „	„ „	—
4 -	„	„	„	„	Decol.	„	„ „	„ „	—
5 -	„	„	„	„	N. Ch.	„	„ „	„ „	—

A. = Acid. G. = Gas. C. = Clot. D. = Decolorization. C.T. = General turbidity. N. Ch. = No change.

14 May 1901.

Source and Number.	Organism.	Motility.	Broth.	Litmus Glucose Broth.	Litmus Lactose Broth.	Litmus Milk.	Gelatine, Slant or Stab.	Agar.	Gram.
C.S. (a) 1 -	Bacillus	Active	G.T.	A.	N. Ch.	A.	Whitish, translucent	Moist, whitish	—
2 -	"	"	"	"	"	"	" "	" "	—
3 -	"	?	"	A. and G.	Decol.	"	" "	" "	—
4 -	"	Active	"	"	A. and G.	"	" "	" "	—
5 -	"	"	"	A.	N. Ch.	"	" "	"	—
6 -	"	"	"	"	"	"	" "	" "	—
C.S. (b) 1 -	"	?	"	A. and slight G.	"	"	" "	" "	—
2 -	"	Active	"	Decol.	Decol.	Decol.	Slow liquefier	Opaque orange-coloured, abundant.	
3 -	"	?	"	A.	N. Ch	A.	Liquefier	Moist, whitish	
4 -	"	Active	"	A. and G.	A.	"	Whitish, translucent	" "	
5 -	"	"	"	N. Ch.	N. Ch.	Alk.	" "	" "	—
6 -	"	?	"	A. and G.	Decol.	A.	" "	" "	—
O.S.T. (a) 1 -	"	Active	"	A.	N. Ch.	"	" "	" "	—
2 -	"	"	"	"	"	"	" "	" "	—
3 -	"	"	"	"	"	"	" "	" "	—
4 -	"	"	"	"	"	"	" "	" "	—
5 -	"	"	"	"	"	"	" "	" "	—
6 -	"	"	"	"	"	"	" "	" "	—
O.S.T. (b) 1 -	"	"	"	"	"	"	" "	" "	—
2 -	"	"	"	"	"	"	" "	" "	—
3 -	"	"	"	"	"	"	" "	" "	—
4 -	"	"	"	"	"	"	" "	" "	—
5 -	"	"	"	"	"	"	" "	" "	—
Cam. (b) 1 -	"	"	"	"	Decol.	A. and C.	Liquefier	" "	—

A. = Acid. G. = Gas. C. = Clot. D. = Decolorization. G.T. = General turbidity. N. Ch. = No change

18 May 1901.

Source and Number.	Organism.	Motility.	Broth.	Litmus Glucose Broth.	Litmus Lactose Broth.	Litmus Milk.	Gelatine, Slant or Stab.	Agar.	Gram.
C.S. (a) 1 -	Bacillus	?	G.T.	N. Ch.	N. Ch.	Alk.	Whitish, translucent	Moist, grey	—
2 -	„	?	„	„	„	„	„ „	„ „	—
3 -	„	?	„	„	„	„	„ „	„ „	—
4	No growth.								
5 -	Bacillus	Active	„	A. and G.	A. and G.	A.	„ „	„ „	—
6 -	„	?	„	N. Ch.	N. Ch.	Alk.	„ „	„ „	—
7 -	„	?	„	„	„	„	„ „	„ „	—
8 -	„	?	„	„	„	„	„ „	„ „	—
9 -	„	Active	„	A. and G.	A. and G.	A. and C.	„ „	„ „	—
C.S. (b) 1 - Taken off as ? B.c.c.	„	?	„	„	N. Ch.	A. & decol., later ? slight Alk.	„ „	„ „	—
2 -	„	?	„	N. Ch.	„	Alk.	—	Transparent, orange, slow g.	—
3 -	„	?	„	A.	„	A. and C.	Liquefier	Moist, grey, orange.	—
4 - Taken off as not B.t.a.	„	?	„	A. and G.	A. and G.	„	Whitish, translucent	Moist, whitish	—
5 -	„	?	„	A.	N. Ch.	„	Liquefier	Moist, grey, orange.	—
O.S.T. (a) 1 -	„	Active	,	N. Ch.	„	Alk.	Greyish, translucent	Moist, whitish	—
2 -	„	„	„	„	„	„	„ „	„ „	—
3 -	„	„	„	„	„	„	„ „	„ „	—
4 -	„	„	„	A.	„	A.	„ „	„ „	—
5 -	„	„	„	N. Ch.	„	Alk.	„ „	„ „	—
O.S.T. (b) 1 -	„	„	„	A.	„	A.	„ „	„ „	—
2 -	„	„	„	„	„	„	„ „	„ „	—
3 -	„	„	„	„	„	„	„ „	„ „	—
4 -	„	„	„	„	„	„	„ „	„ „	—
Carr. (b) 1 -	„	„	„	A. and G.	Decol.	„	„ „	„ „	—
2 -	„	?	„	N. Ch.	N. Ch.	Alk.	„ „	„ „	—
3 -	No growth.								
4 -	Bacillus	Active	G.T.	A. and G.	„	A., later Alk.	„ „	„ „	—
? B.c.c. 5 -	„	Motile	„	„	„	A.	„ „	„ „	—
6 -	„	?	„	„	„	A., later Alk.	„ „	„ „	—

A. = Acid. G. = Gas. C. = Clot

D. = Decolorization. G. T. = General Turbidity. N. Ch = No change.

25TH MAY 1901.

Source and Number.	Organism.	Motility.	Broth.	Litmus Glucose Broth.	Litmus Lactose Broth.	Litmus Milk.	Gelatine Slant.	Agar.	Gram
C.S. (a) 1 - -	Bacillus	?	G.T.	A. and G.	N.Ch.	A.	Greyish, moist, translucent.	Moist, grey, white translucent.	—
2 - -	"	+	"	N.Ch.	"	N.Ch. or slight Alkali.	" "	" "	—
Many long threads 3 - -	"	?	"	"	"	"	" "	" "	—
4 - -	"	?	"	"	"	"	" "	" "	—
5 - -	"	?	"	"	"	"	" "	" "	—
6 - -	"	?	"	"	"	"	" "	" "	—
C.S. (b) 1 - -	"	?	"	A. and G.	Decol.	A.	" "	" "	—
2 - -	Coccus	—	Slight granular G.T.	A.	A.	"	" "	" "	+
3 - -	Bacillus	Active	G.T.	N.Ch.	N.Ch.	Alkali	" "	" "	—
4 - -	No growth.								
5 - -	Bacillus	Active	"	"	"	"	" "	" "	—
.S.T. (a) 1 - -	"	Very active	"	"	"	"	" "	" "	—
2 - -	"	"	"	"	"	"	" "	" "	—
3 - -	"	"	"	"	"	"	" "	" "	—
4 - -	"	"	"	"	"	"	" "	" "	—
5 - -	"	"	"	"	"	"	" "	" "	—
6 - -	"	"	"	"	"	"	" "	" "	—
.S.T. (b) 1 - -	"	"	"		"	"	" "	" "	—
2 - -	"	Active	"	A.	"	A.	" "	" "	—
3 - -	"	"	"	A. and G	Decol.	"	Liquifier	" "	—
4 - -	"	"	"	A.	N.Ch.	"	"	" "	—
am. (b) 1 - -	"	"	"	N.Ch.	"	Decol. Clot	"	Whitish, translucent.	—
2 - -	"	"	"	A. and G.	Decol.	A. and C.	Whitish, translucent	" "	—
3 - -	"	Very active	"	N.Ch.	"	? A. and C. and fluorescence.	Liq. fluorescent green	Whitish, green fluorescence.	—
4 - -	"	"	"	"	"	"	" "	" "	—
5 - -	"	Active	"	A. and G.	"	A. and C.	—	Whitish translucent.	—
6 - -	"	"	"	N.Ch.	N.Ch.	Decol. Clot	Liquifier	" "	—
7 - -	"	"	"	"	"	"	"	"	—

A. = Acid. G. = Gas. C. = Clot. D. = Decolorization. G.T. = General Turbidity. N.Ch. = No change.

No. of B.T.A. present per c.c. in Series I and II.

Date.	C.S. (a).	C.S. (b).	O.S.T. (a).	O.S.T. (b).	Dibdin, a.	Dibdin, b.
April 2 - - -	? 384,000	205,000	354,000	? 100,000	? 400,000	100,000
3 -	4,000	68,000	Not recovered.	146,000	Not recovered.	294,000
9 - -	Not recovered.	Not recovered.	132,000	23,000	80,000	Not recovered
11 -	22,000	1,850	106,000	11,400	8,500	170
15 -	6,300	1,000	Not recovered.	Not recovered.	Not recovered.	Not recovered.
17 -	Not recovered.	Not recovered.	11,800	1,000	3,100	75
May 1 -	—	—	—	—	—	—

No. of B.T.A. present per c.c. in Series III. and IV.

Date.	C.S. (a).	C.S. (b).	O.S.T. (a).	O.S.T. (b).	Cameron, a.	Cameron, b.
May 8 - - -	3,000,000	8,500,000	1,700,000	24,000,000	8,500,000	12,000,000
" 14 - - -	131,000	Not recovered.	400,000	30,000	3,300	Not recovered.
" 18 - - -	Not recovered.	"	240,000	2,000	33	"
" 25 - - -	"	"	Not recovered.	600	Not recovered.	"

FILTRATION EXPERIMENTS.

THE REDUCTION IN THE NUMBER OF BACTERIA IN A BIOLOGICAL EFFLUENT (DOUBLE CONTACT) BY MEANS OF FILTRATION.

BY PROFESSOR BOYCE AND DRS. MACCONKEY, GRÜNBAUM AND HILL.

Reasons for Making the Experiments.

The numerous analyses of biological effluents which were carried out by the Royal Commission having demonstrated that the total number of bacteria present in these effluents as well as the number of the *Bacillus coli communis* was usually large, the Commission decided that the effect of subsequent filtration of the effluent should be tried in order to see what further reduction could be effected. The most convincing way to have carried out this experiment would have been to filter the effluent on a large scale through some four feet of suitable soil, and over a considerable area. Owing to the difficulty of levels at West Derby this extensive experiment could not be conducted, and it was decided to make use of small experimental filters. Such small filters have in the past proved of considerable use in those engaged in sewage and water experiments, and under special circumstances, viz., when experimenting with pathogenic organisms, they obviate that risk of spreading infection which might occur in the case of experiments conducted on a large scale on a farm.

Nature of the Experiments.

The experiments consisted in passing at a definite rate a biological effluent of known bacterial impurity through four feet of sand or good soil, and in daily analysing the filtrate and in noting the reduction both in the total numbers of bacteria and in the *B. coli. communis* and the *B. enteritidis sporogenes*. The experiments were subsequently extended to ascertain whether if certain colour bacteria, viz., the *Bacillus prodigiosus* and the *B. pyocyaneus*, were placed in the biological effluent supplying the filters, they would appear in the filtrate, and if so how soon after filtration this would occur, also when they would disappear again. In the same way experiments were made with the Bacillus typhosus.

These experiments would show whether, if an effluent containing pathogenic organisms passed on to land, multiplication of these harmful organisms might or might not be expected to take place in the soil.

The filters were made in 9in. drain pipes, and were 4ft. deep, with the draw-off tap as close to the bottom as possible. Filters, 1, 2, and 4 were filled with sand; Filter 3 with light soil taken from one of the fields on the West Derby Sewage Farm. The bottom of each filter was filled with 3in. of graded gravel.

Filter 1 was washed by a continuous stream of tap water for 24 hours and subsequently with distilled water. In Filter 4 the sand was thoroughly washed before packing. Filters 2 and 3 were not washed.

The filters were started on November 8th by running on to them Dibdin Effluent obtained from the beds at the West Derby Farm.

The rate of flow was carefully adjusted. In the commencement it was at the rate of 4 litres per hour, which gives 1,900,000 gallons per acre per 24 hours; later the rate was reduced to 10 and 4 litres per 12 hours, or 392,000 and 157,000 gallons respectively per acre per 24 hours. At these rates the effluent dripped on to the filters, and the filtrate came away at about the same rate.

In calculating the rate of flow, we had the experience of the Water Engineer of the City of Liverpool.

After carefully collecting the filtrate from each filter, the following series of experiments were undertaken:—

1. The original effluent flowing on to all four filters was carefully analysed.
   - (a.) For numbers.
   - (b.) For B. coli communis.
   - (c.) For B. enteritidis sporogenes.
   - (d.) For other organisms.

2. The filtrate from each filter was examined precisely as in the preceding case.

The Bacteriological Analyses. Methods.

For quantitative analysis six gelatine plates were made of each filtrate and incubated for 3 days at 20° C.

For the analysis of B. coli communis, 1 in 1,000 carbolic agar was used and incubated at 42° C.

For the analysis of B. enteritidis sporogenes, freshly prepared milk tubes, heated to 80° C. for 15 minutes and incubated anaerobically, were used. For the test of pathogenicity guinea pigs have been used.

Results. Duration of Experiments.

The experiments extended from the 8th November, 1899, to April 6th, 1900.

Bacterial Condition of the Dibdin Effluent Employed.

The Dibdin effluent which supplied the filters was not, as the bacteriological analyses show, a good one.

The total number of bacteria per c.c. as the average of 26 analyses was 837,842.

The average number of B. coli communis out of 25 determinations was 9,812 per c.c.

The B. enteritidis sporogenes was present 7 times in 0·01 c.c. and 16 times in 0·1 c.c. out of 25 determinations.

In large quantity the effluent was turbid and occasionally underwent decomposition on standing.

The Action of the Filters.

The following is the summary of the four filters:—

Experimental Filter No. 1.

Number of determinations - - -	23
Average number of bacteria - -	79,780
Average number of B. coli - -	125

B. enteritidis sporogenes present twice.

Experimental Filter No. 2.

Number of determinations - -	24
Average number of bacteria - -	50,762
Average number of B. coli - -	590

B. enteritidis sporogenes present 8 times in 25.

Experimental Filter No. 3.

Number of determinations - - -	21
Average number of bacteria - -	31,665
Average number of B. coli communis -	49

B. enteritidis sporogenes present 11 times in 24.

Experimental Filter No. 4.

Number of determinations - - -	27
Average number of bacteria - -	113,790
Average number of B. coli communis -	432

B. enteritidis sporogenes present 5 times in 20.

In Table I. the total number of bacteria, the B. coli communis and the B. enteritidis sporogenes, are given in columns side by side. In Tables II. and III. the number of B. coli communis per c.c. is recorded in graphic form.

It was found difficult to regulate precisely the rate of flow over 24 hours, as accidents, due to blocking of pipes and variation of pressure, occurred, but from the number of observations made, it may be fairly concluded that marked diminution of the number of bacteria occurred when the rate of flow was decreased.

Tables II. and III. show very clearly the diminution in the numbers of the B. coli communis, the shaded columns showing at a glance the variations from day to day. Corresponding variations occurred with certain exceptions in the case of the total numbers of bacteria.

The rate of flow to commence with was 4 litres per hour. At this rate there is a slight average reduction both of the total numbers of bacteria and of the B. coli communis; this continued from Nov. 11th to Nov. 14th. On Nov. 15th the rate of flow was decreased to 10 litres in 12 hours. There is a marked diminution in numbers and B. coli except in the fourth filter, where the rate of flow was irregular. On the 16th and 17th November the rate of flow was still further decreased to 4 litres in 12 hours, and there is a corresponding diminution in the number of bacteria. This rate was fairly evenly maintained in Filter No. 3 to the end of the observation on January 10th, and the B. coli in the filtrate remained very low. On Dec. 1st the rate of flow in Filters

Nos. 1, 2, and 4 was increased to the original speed of 4 litres per hours, and there is a corresponding rise of B. coli until Dec. 5th, when the rate was again reduced to 4 litres per 12 hours. At the slow rate of flow of 4 litres in 12 hours there is a very great diminution in the B. coli communis, the number in some observations falling below 10 per c.c., whereas the effluent which went on contained in round numbers 10,000 B. coli per c.c.

Influence of the Composition of the Filter upon the Quality of the Filtrate.

On looking at Tables I.-III. it will be seen that the filter composed of the fine sandy soil gave the greatest reduction in the number of the B. coli communis.

Filters 1, 2 and 3 contained to commence with all kinds of bacteria, those of the earth filter, No. 3 being naturally especially numerous, as it was light mould taken from one of the fields of the sewage farm. The sand of filter 4 on the other hand, had been very carefully washed, and therefore contained fewer organisms. But, as seen by the Tables, the results of this clean sand filter are as regards the B. coli communis less satisfactory than the earth filter. It is most probable that the multitude of other organisms which are present in the mould act injuriously upon the B. coli and lessens its chances of passing through in the filtrate. Earth also, by forming a more compact mass than sand, will no doubt act as a more efficient filter.

In none of the experiments is there evidence of the multiplication of the B. coli in the substance of the filter; if there had been, one would have expected an increase in the filtrates towards the conclusion of the experiments. This did not occur.

In conclusion the experiments indicate that the reduction in numbers of the bacteria and of the B. coli is both due to filtration, being dependent therefore upon the rate of flow and the depth and nature of filter, and also to biological action, which further produces a reduction in intestinal organisms like the B. coli. In the struggle for life in the filter the conditions are more favourable to the survival and growth of the organisms which abound in earth than to the B. coli group, which are normally parasitic in the intestine, and the products of the former will act injuriously upon the life of the B. coli communis.

EXPERIMENTS WITH THE FILTRATION OF SPECIAL BACTERIA, VIZ., BACILLUS PRODIGIOSUS, B. PYOCYANEUS, B. TYPHOSUS.

Duration of Experiments.

The experiments were made from January 12th, 1900, to April 6th, 1900.

Method.

To the effluent which supplied the four filters was added the scrapings from the surfaces of Agar plates upon which were growing cultivations of the B. prodigiosus and B. pyocyaneus.

Reasons for Using B. Prodigiosus and B. Pyocyaneus.

These organisms were used because owing to their brilliant colours they could readily be recognised if present in plate cultivations of the filtrates.

Rate of Flow of Filters.

The rate of flow varied from 10 to 4 litres per 12 hours, and the filtering action as regards the total number of all kinds of bacteria present is graphically recorded in Tables IV. and V. by black columns, whilst the smaller red and green columns indicate the presence of B. prodigiosus or B. pyocyaneus.

Results.

The first inoculation of the effluent supplying filters with B. prodigiosus and B. pyocyaneus took place on January 12th. On the 13th and 15th no coloured organisms had appeared, and the effluent was again plentifully inoculated with B. prodigiosus. No B. prodigiosus appeared in the filtrate, and a fresh inoculation was made. Bacteriological analyses were made daily, but it was not till January 23rd, or ten days after the first inoculation. that the B. prodigiosus appeared in the filtrate of filters No. 1 and No. 2, and then they were present in the proportion on an average of only 33 per c.c.; the total number of bacteria present at the same time varied from 500 to 1,500 per c.c.

The next date on which B. prodigiosus appeared was on January 30th; it was only present in the filtrate of filter No. 1 to the extent of 34 per c.c. Upon no subsequent occasion to the conclusion of the observations upon April 6th was the B. prodigiosus found.

Up to January 30th the B. pyocyaneus had not appeared upon the plates. On February 1st a green organism was round in the plates made from the filtrate of filter No. 4, and again on February 12th a similar organism appeared in the filtrate from filter No. 3. The green colour producing bacteria were present in very small proportion. It thus took seventeen days from the original inoculation before the B. pyocyaneus appeared in the filtrate in very small quantity in two out of the four filters.

On March 5th and 12th the surfaces of filters 2 and 3 were carefully examined for the B. prodigiosus and the B. pyocyaneus, but neither organism was found.

Results.

These experiments with the two coloured bacteria corroborate the previous observations upon the B. coli. Although large quantities of these organisms were run on to the filters, they only appeared in the filtrates of some of the filters after many days, and then only in very small numbers. They had been intercepted by the filtering action of the material of the filters. And as in the case of the B. coli, there was no evidence of multiplication in the filters. Had this taken place, these organisms would have been regularly found in the filtrates. On the contrary, again, as in the case of the B. coli, the conditions were not favourable to their multiplication. This is shown by the fact that analysis of the sand of the filters on March 5th failed to show them, they had died out.

Experiments with Bacillus Typhosus.

It having been shown in the previous experiments that both the conditions for the growth and multiplication of the B. coli, B. prodigiosus, and B. pyocyaneus in the filters were not favourable, and also that by the action of filtration these organisms were greatly reduced in their passage through the filters, it was considered useful to ascertain whether the B. typhosus, the bacterium which more than any other renders sewage nocuous, behaved like those organisms, or whether there was evidence that they multiplied in the filters if they were supplied to them in the effluent which was poured on them.

In experiments with the B. typhosus there is very great difficulty in recognising colonies of this bacillus in plate cultivations of the filtrate owing to the presence of the B. coli. This renders it necessary to pick out all the coli-like colonies and to subject them to special differential tests in order to ascertain whether some of them may not be typhoid colonies. When these experiments were made MacConkey's medium had not been introduced, and all the analyses were made with Carbol Agar, in which medium the colon and typhoid colonies closely resemble one another.

The experiments were commenced on February 14th, when 13 litres of effluent which was allowed to run on to filter No. 3 (earth filter) at the rate of between 4 litres and 10 litres per 12 hours, was inoculated with 100 c.c. of a pure cultivation in broth of the typhoid bacillus.

The filtrate was tested on the 15th, 16th, 17th, and 19th, but no B. typhosus was found.

On the 19th, 200 c.c. of a typhoid culture were added to another 13 litres of effluent, and analyses of the filtrate made on the 22nd February and on the 5th of March, but without result.

On March 5th a fresh inoculation with 100 c.c. of typhoid culture took place, and this effluent was continuously poured through the filter till April 6th.

Bacteriological analyses of the filtrate were made on the 7th, 8th, 9th, 10th, 12th, 13th, 16th, 17th, 19th, 20th, 21st, 22nd, 23rd, 24th, 26th, and 29th March, and on the 4th and 6th of April, but the typhoid bacillus was never found.

Conclusions.

From February 14th to March 5th altogether 400 c.c. of a pure cultivation of the typhoid bacillus in broth mixed with the West Derby effluent had been passed into the earth filter, yet in no instance up to April 6th had any of the numerous colonies which had been picked out of the carbol agar plates given the reactions of the typhoid bacillus.

These results are more striking than those obtained in the case of the two coloured organisms, and demonstrate the action of the earth filter in removing a pathogenic organism like the B. typhosus from sewage. It is most probable that the action of the filter was similar to that described in the previous cases, viz., mechanical filtration, and the fact of the conditions in the filter being hostile to the growth and multiplication of the typhoid bacillus.

EXPERIMENTS WITH THE BACILLUS ANTHRACIS.

Experiments were commenced on March 7, 1900, when the effluent running on to filter No. 1 was inoculated with a culture of B. anthracis. The filtrate was tested by cultivation upon agar plates, incubated at 42° C., upon March, 8th, 9th, 10th, 13th, 16th, 19th, 20th, 21st, 22nd, 23rd, and 26th. On March 27th, the effluent was re-inoculated with a fresh broth culture of B. anthracis, and carbol agar exclusively used for the plate cultivations of the filtrate. Analyses upon March 28th, 29th, and April 4th, 5th, and 6th, all gave negative results. These experiments agree with the preceding ones. The rate of filtration varied between 10 and 4 litres per 12 hours.

General Conclusions.

When an effluent containing upon an average 800,000 bacteria per c.c. and 10,000 B. coli per c.c. is passed through a depth of 4 feet of soil at a slow rate (viz., between 10 and 4 litres per 12 hours), there is a very great reduction in the total numbers and in the B. coli, and the chance of a very pathogenic bacterium like the B. typhosus appearing in the filtrate must be exceedingly small.

When it is remembered that normally the B. typhosus is not present in the excreta of all cases of typhoid, whilst the B. coli is always present in the fæces, and that the proportion of typhoid cases to the total number of the population is not large, that typhoid excreta are usually disinfected, and that it has not been shown that favourable conditions exist in sewage for the multiplication of the typhoid bacillus, it appears evident that land or other method of efficient filtration must totally remove this organism from a Dibdin effluent did it happen to be present.

In the preceding experiments the B. typhosus was mixed with the effluent flowing on to the filters in far larger proportion than would ever occur in nature, and yet it could not be found in the filtrate.

November 1901. *R. Boyce.*

TABLE I.

TABLE lustrating effect of various Filtering Media on the West Derby Dibdin Bed Effluent as regards Numbers of Bacteria, B. Coli, and B. Enteritidis Sporogenes.

Date.	WEST DERBY.—DIBDIN EFFLUENT.			EFFLUENT.—FILTER No. 1. Virgin Rivington Sand.			EFFLUENT.—FILTER No. II. Used Rivington Sand.			EFFLUENT.— FILTER No. III. Soil West Derby Farm.			EFFLUENT.—FILTER No. IV. Fine Sea Sand Washed.		
	Number of Bacteria.	Bacillus Coli Communis per cc.	Bacillus Enteritidis Sporogenes.	Number of Bacteria.	Bacillus Coli Communis per cc.	Bacillus Enteritidis Sporogenes.	Number of Bacteria.	Bacillus Coli Communis per cc.	Bacillus Enteritidis Sporogenes.	Number of Bacteria.	Bacillus Coli Communis per cc.	Bacillus Enteritidis Sporogenes.	Number of Bacteria.	Bacillus Coli Communis per cc.	Bacillus Enteritidis Sporogenes.
1899:			In 0·01 cc.												
8 November	270,000	11,030	Present	450,000	—	—	—	—	—	—	—	—	44,000	435	—
9 November	325,000	3,275	Present	—	—	—	—	—	—	—	—	—	125,000	675	Absent in 0·1 cc.
10 November	Re-charged	—	—	—	—	—	—	—	—	—	—	—	20,000	925	—
11 November	220,000	21,370	Present	10,500	233	—	294,000	3,300	Absent in 0·5 cc.	57,000	Absent	—	105,000	2,183	—
13 November	4,327,000	12,380	Present	505,700	540	Absent in 0·5 cc.	288,700	3,083	Present in 0·5 cc.	102,500	Absent	Present in 0·1 cc.	521,000	1,020	—
14 November	937,000	24,070	Present	1,300,000	1,415	—	477,000	1,580	Present in 1 cc.	321,000	905	Present in 0·5 cc.	1,700,000	3,940	Absent
15 November	2,060,000	12,770	Present	349,000	307	—	89,000	240	Present in 1 cc.	224,000	273	Present in 1 cc.	1,420,000	1,380	Absent
16 November	2,187,000	7,433	Present	337,500	Absent	Absent in 1 cc.	13,340	Absent	Absent	163,000	40	Absent	283,200	93	Absent
17 November	1,440,000	14,570	Present in 0·1 cc.	9,660	30	Absent	12,000	73	Present	70,600	Absent	Present	50,800	86	Absent
18 November	1,284,000	13,000	—	2,600	153	—	20,000	280 ?	—	4,600	20	—	9,600	53	—
27 November	20,000	100	Present	41,000	57	Present	47,000	40	Present	23,000	Absent	Present	39,000	30	Absent
28 November	667,000	22,500	Present	20,400	18	Absent	22,900	616	Present	20,700	30	Absent	74,700	122	Present
29 November	1,196,700	—	Present	48,000	—	Present	148,200	—	Present	11,800	—	Present	91,100	—	Present
30 November	1,690,000	14,367	Present	—	—	—	1 in 100, 3rd day, liquefied.	—	Present	—	—	—	1 in 100, 3rd day, liquefied.	690	Present
1 December	—	—	—	72,000	927	—	273,200	2,793	—	20,500	40	—	220,000	2,045	—
1 December	840,000	20,100	Present	—	—	—	127,000	5,253	—	13,000	67	—	131,000	2,627	—
5 December	2,460,000	11,000	Present	21,000	320	Absent	15,000	77	Absent	23,000	53	Present	5,000	30	Absent
7 December	720,000	1,000	Present	4,800	10	Absent	9,600	17	Absent	1 in 100	40	Present	5,500	20	Absent
8 December	23,000	—	Present	6,700	—	Absent	800	—	Absent	5,700	—	Present	2,500	—	Present
9 December	13,000	Doubtful, if any, 200 (?)	Present	2,700	22	Absent	200	12	Absent	4,500	8	Present	9,300	15	Absent
12 December	48,000	2,700	Present	1,600	11	Absent	621	7	Absent	2,800	6	Present	1,230	27	Absent
13 December	13,700	407	Present	1,400	10	Absent	440	16	Absent	2,000	45	Absent	1,640	26	Absent
14 December	23,700	—	Present	2,300	—	—	1,640	—	—	4,400	—	—	2,070	—	—
15 December	7,700	Absent in ·001 cc.	Absent	1,900	3	Absent	430	—	Absent	3,470	65	Absent	2,070	10	Absent
16 December	12,200	—	Absent	2,500	—	Absent	390	—	Absent	1,800	—	Absent	1,560	—	Absent
18 December	3,870	—	Present	1,670	—	Absent	470	—	Absent	2,100	—	Absent	1,340	—	Absent
19 December	157,200	6,633	Present	2,000	7	Absent	—	—	—	1,300	5	Absent	3,840	8	Absent
1900:															
8 January	81,000	—	—	1,700	75	Absent	2,200	196	—	2,340	2	Absent	4,860	131	Absent
10 January	360,000	—	—	1,470	9	Absent	270	3	Absent	800	10	Absent	3,700	103	Absent
13 January	—	—	—	2,540	—	—	67	—	—	760	—	—	1,940	—	—
15 January	65,000	—	—	1,640	—	—	70	—	—	750	—	—	6,940	—	—
17 January	—	—	—	470	—	—	240	—	—	840	—	—	840	—	—
19 January	155,000	—	—	400	Absent	—	300	—	—	640	—	—	1,400	—	—
20 January	17,000	—	—	570	—	—	170	1	—	540	—	—	440	—	—
23 January	160,000	—	—	1,200	—	—	600	—	—	750	—	—	700	—	—
24 January	89,000	—	—	1,000	219	—	400	109	Absent	940	Absent	Absent	240	103	—
25 January	—	—	—	7,500	239	—	7,370	391	—	2,270	8	—	2,300	157	—
26 January	92,000	—	—	1,440	120	—	3,900	400	—	600	Overgrown	—	1,840	191	—
27 January	—	—	—	6,070	—	Absent	4,500	—	—	540	—	—	—	—	—
29 January	119,000	—	—	5,140	—	Absent	6,900	—	—	400	—	Absent	2,770	—	Absent
27 January	125,000	—	—	7,400	—	—	13,100	—	—	540	—	—	—	—	—

Table Showing the Number of B. Coli in the Filtered Effluents of Filters I. & II.

Filter N° I.
Virgin sand.

Table II.

Filter N° II.
Used sand.

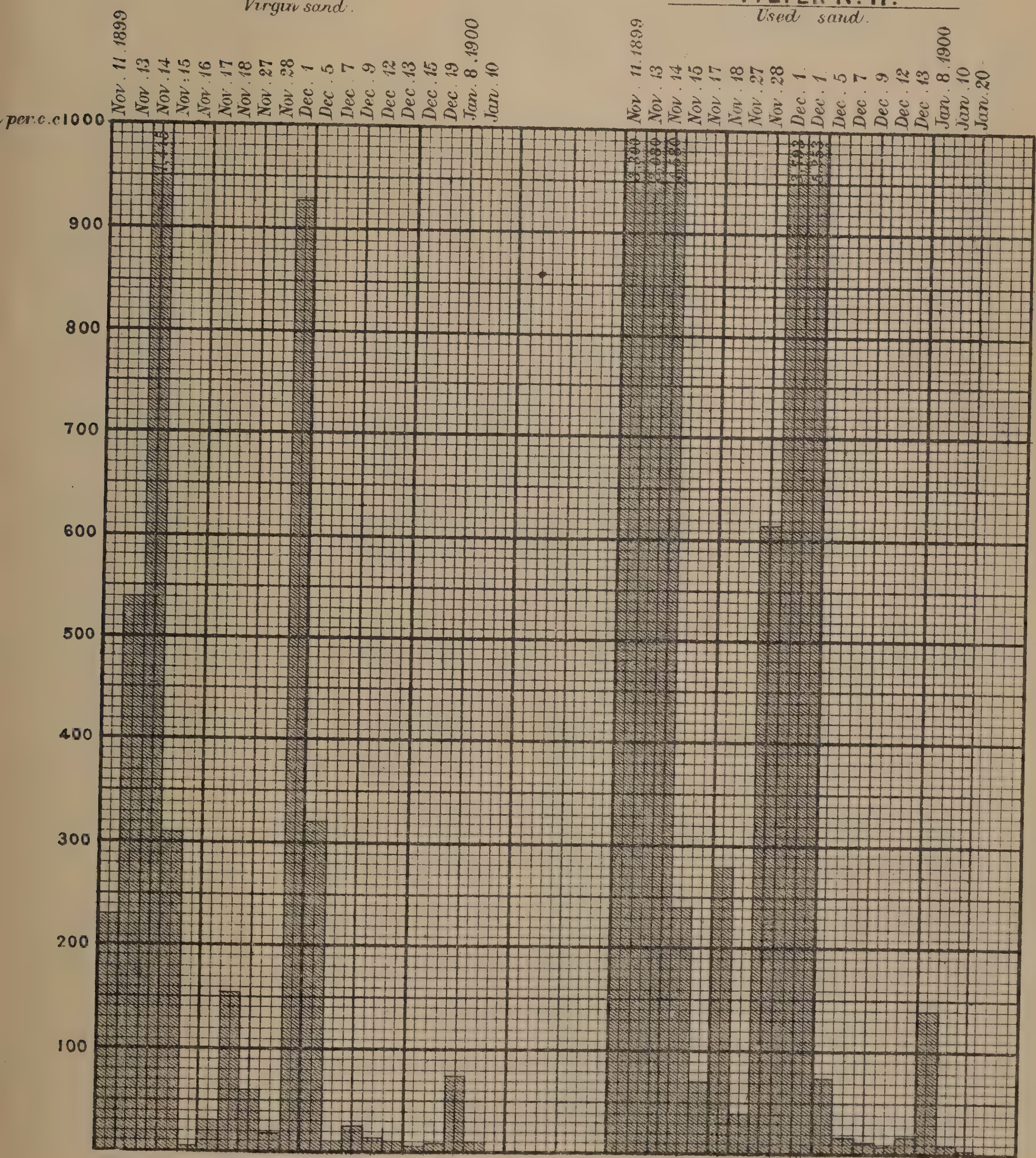

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TABLE SHOWING THE NUMBER OF B. COLI IN THE FILTERED EFFLUENTS OF FILTERS III & IV.

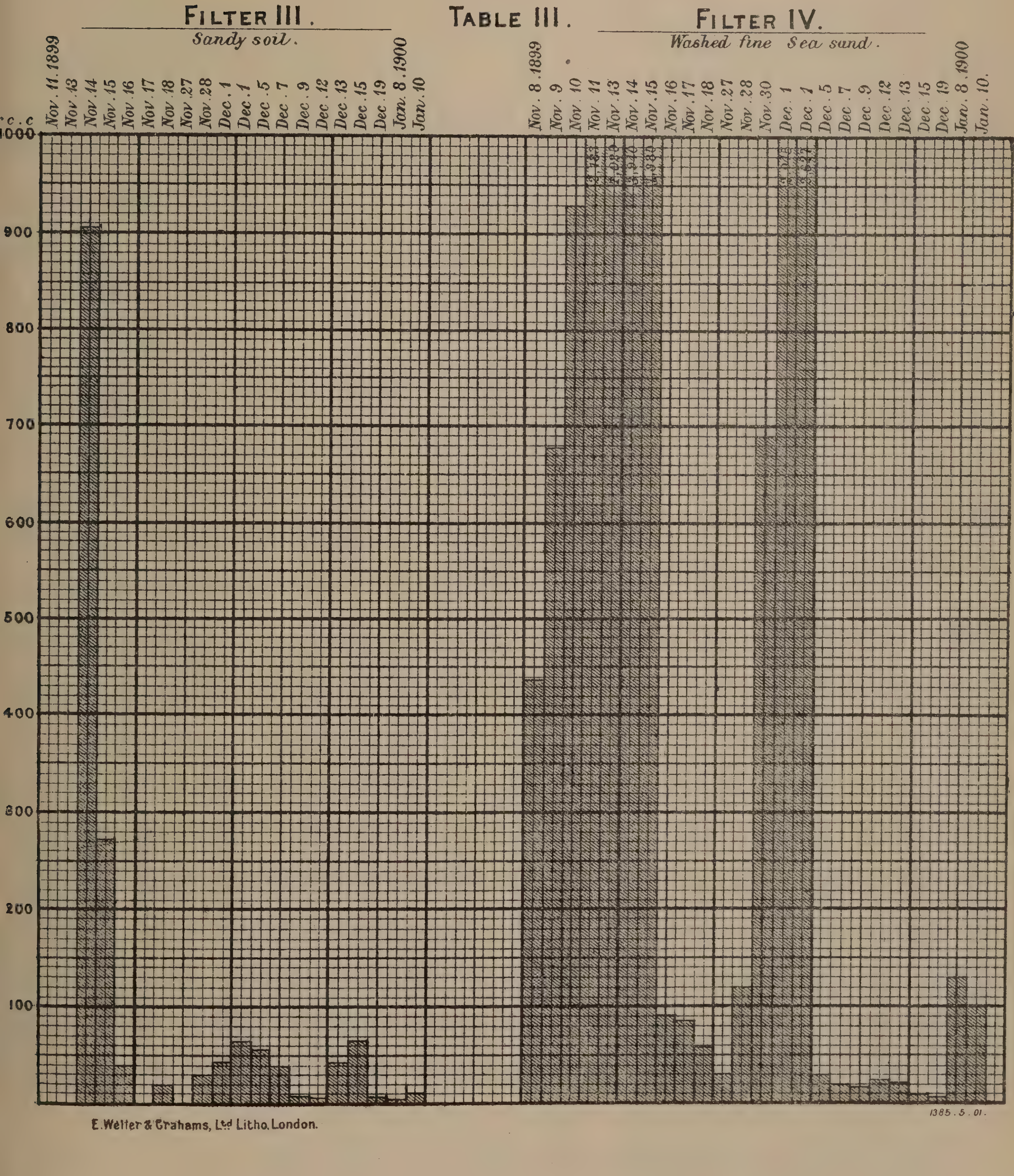

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TABLE SHOWING WHEN THE B. PRODIGIOSUS APPEARED IN FILTERS I & II.

FILTER I | TABLE IV. | FILTER II.

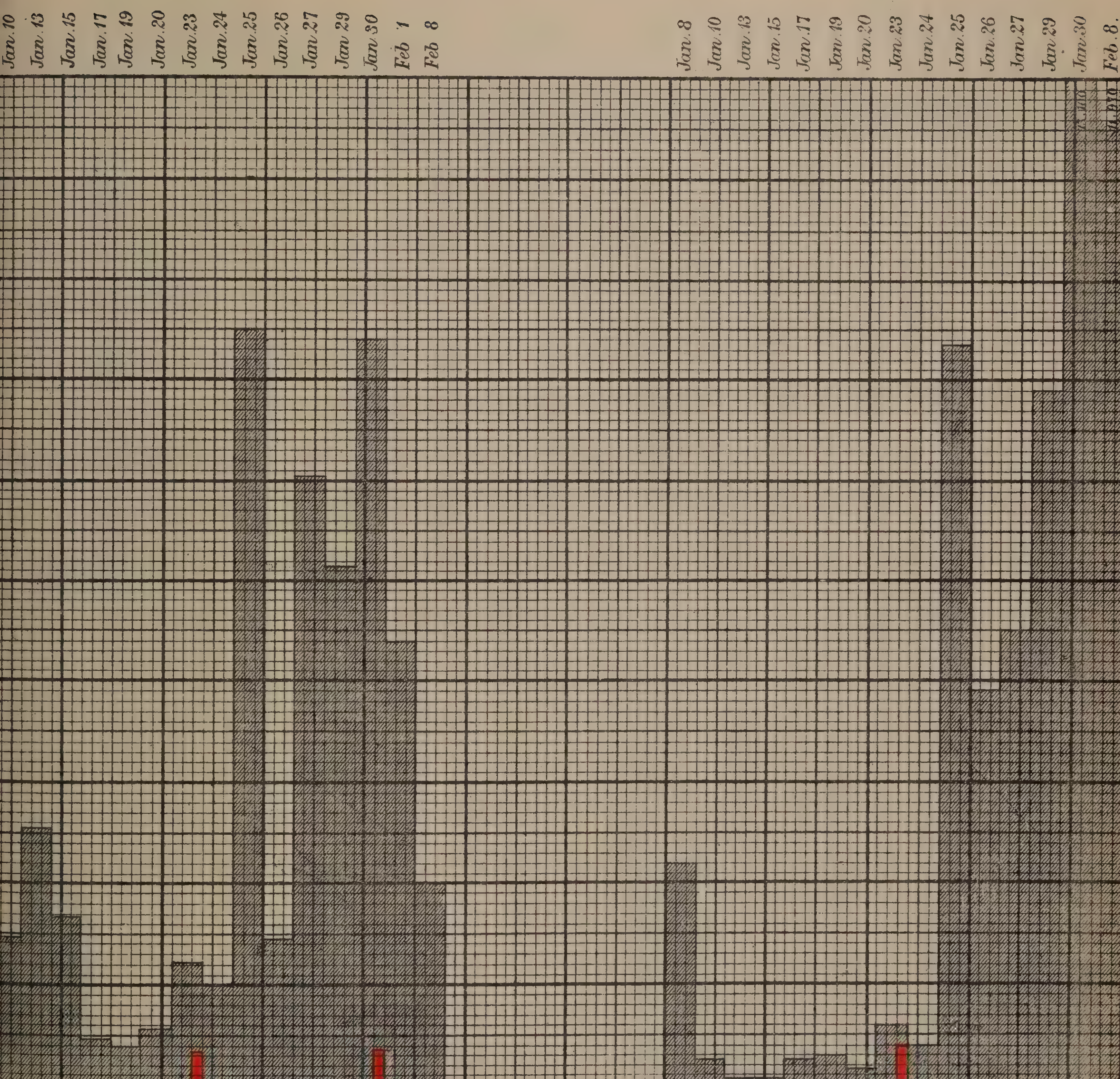

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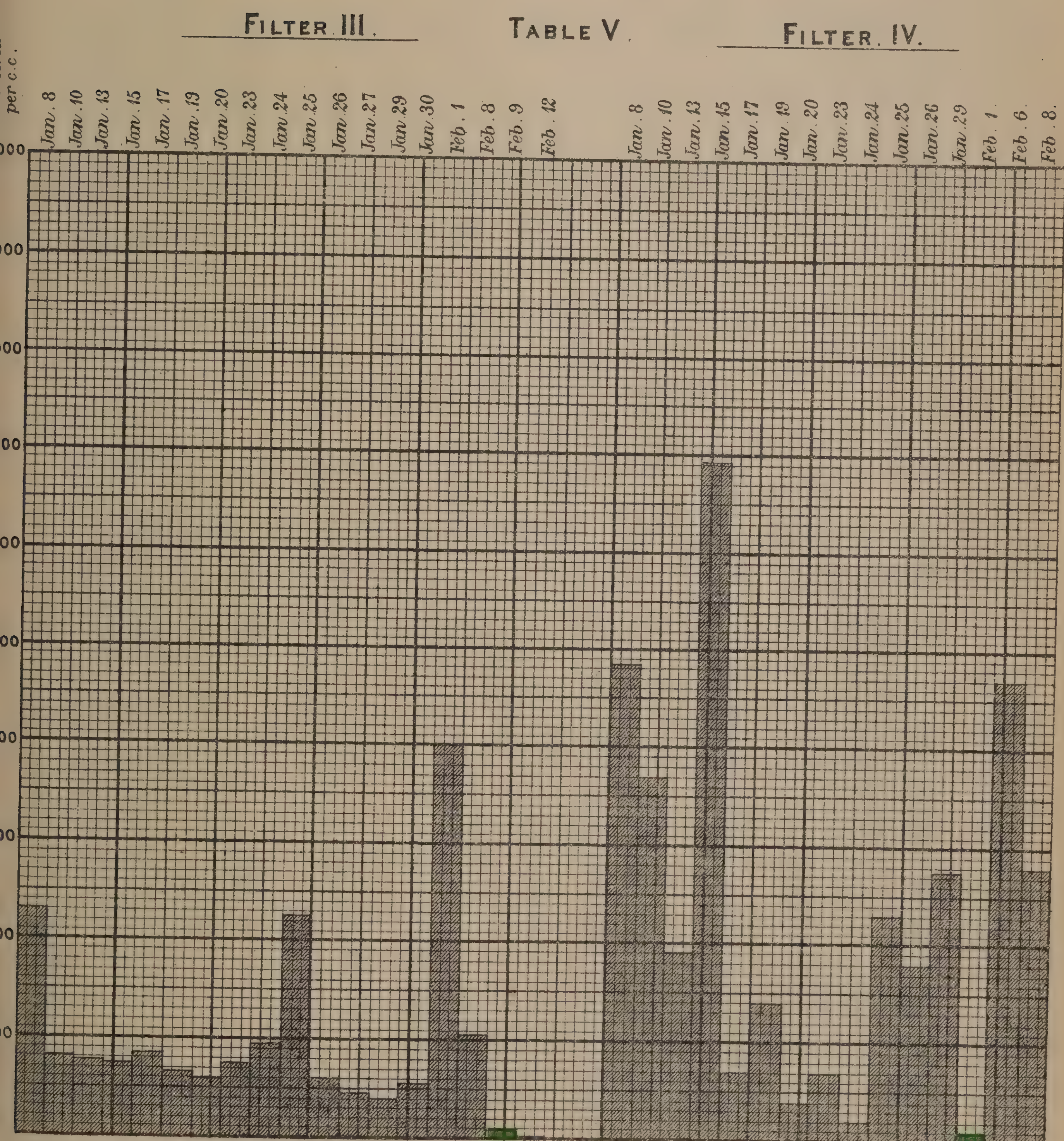
Table Showing when the B. Pyocyancus appeared in Filters III & IV.



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INVESTIGATION OF THE RIVER SEVERN IN THE SHREWSBURY DISTRICT.

By Professor Boyce and Doctors Grünbaum, MacConkey, and Hill.

CONTENTS

REASONS FOR THE INVESTIGATIONS.

The bacteriological analyses of the officers of the Royal Commission having shown that the effluents derived from bacterial methods of sewage treatment usually showed insufficient purification as measured by the "Coli" and "Enteritidis Sporogenes" tests; and as it was evident that these effluents might in the future pass into streams and rivers used for drinking or domestic purposes where the presence of pathogenic bacteria would be dangerous, it was considered of primary importance to ascertain the risk of allowing such effluents to pass into streams and rivers.

Although much had been published upon the effect of sewage pollution upon rivers, more especially upon the Continent, nevertheless definite bacteriological data based upon the most recent methods of measuring intestinal polution were wanting, and it was thought that with the improved methods, which the officers of the Commission had devised, much definite and practical information could be gained upon the following amongst other questions:—

1. WHAT HAPPENED TO THE INTESTINAL BACTERIA WHEN THEY PASSED INTO THE RIVER?

2. HOW FAR DOWN THE RIVER WERE THEY CARRIED? WAS THERE EVIDENCE OF MULTIPLICATION?

3. DID THEY ACCUMULATE AND MULTIPLY IN THE MUD OF THE RIVER?

4. AT WHAT DISTANCE BELOW THE SOURCE OF POLLUTION WAS IT SAFE TO DRINK THE WATER?

5. WHAT WAS THE SIMPLEST AND MOST RAPID MEANS OF DETECTING INTESTINAL BACTERIAL POLLUTION IN THE RIVER?

6. WHAT, IF ANY, WAS THE EFFECT OF SEASONS UPON THE BACTERIA OF THE RIVER?

It was originally intended to examine a river into which a biological effluent passed, but as a suitable place presenting this condition could not be found, it was determined to carry out the investigation upon the River Severn at Shrewsbury and to make the observations extend over a period of at least twelve months.

The River Severn at Shrewsbury presented great advantages for this investigation.

1. IT WAS COMPARATIVELY NEAR THE CENTRAL LABORATORIES AT LIVERPOOL.

2. IT WAS A TYPICAL EXAMPLE OF A RIVER USED FOR DRINKING AND DOMESTIC PURPOSES AND FOR FISHING.

3. ITS VOLUME AND VELOCITY COULD BE READILY DETERMINED.

4. IT WAS EXCEEDINGLY TORTUOUS AND THEREFORE COMPARATIVELY LONG DISTANCES BY RIVER WERE REPRESENTED BY VERY SHORT DISTANCES AS THE CROW FLIES, RENDERING POINTS OF OBSERVATION WITHIN EASY REACH OF ONE ANOTHER.

5. IT RECEIVED THE WHOLE OF THE SEWAGE OF THE TOWN OF SHREWSBURY.

6. WE HAD ALREADY EXAMINED THE UNPOLLUTED STREAMS OF PORTIONS OF THE WATERSHED.

The only disadvantage was that crude sewage and not an effluent passed into the river. But the bacterial problems in the two cases were closely similar, the difference lying in the fact that in the case of crude sewage the bacteria were more numerous, and that the solids passed into the river might be the means of affording a more suitable nidus for the multiplication and extension of micro-organisms. But these apparent disadvantages were nevertheless of use, because no good biological effluent could be so bad as crude sewage, and if it were found that there was no evidence of multiplication, and that the organisms did not pass far down the stream, then clearly in the case of an effluent the results would be still more satisfactory.

There have been other advantages, for the Severn has afforded an opportunity of studying the harmful effect of crude sewage pollution, and has opened up many collateral investigations directly bearing upon the question of sewage disposal.

DESCRIPTION OF THE RIVER SEVERN.

The stretch of river over which the investigations were made measured 26 miles, starting from the County Asylum, 2 miles above Shrewsbury Waterworks, and ending at Iron Bridge, 24 miles lower down. The most numerous observations were, however, conducted over a smaller length of river, viz., from the Asylum to Cressage—a distance of 18 miles. Between these points the river is exceedingly tortuous, and in passing through Shrewsbury it forms a letter S, of which the lower half nearly encircles the town. The distance between the two nearest points of the S is less than 300 yards.

The *width* varies considerably at different points, the average being about 200ft. Where broadest the river is usually shallowest, and in dry weather we found that navigation was difficult at these points even with our small boat.

The *velocity* of the river is, of course, very different according to place and season. It is great when the river is in flood, except where it is very deep, *e.g.*, just above English Bridge; and also at most times in certain definite places, *e.g.*, in Shrewsbury just above the Waterworks, through the English Bridge, through and just below the railway bridge; and at many spots below Shrewsbury.

The velocity has been estimated on two occasions at the same spot, viz., at Ferry I., by Mr. Kershaw. On July 12th, 1900, it was only 30ft. per minute, the volume at the same time being 112,000,000 gals. per 24 hours; on January 6th, 1901, 180ft. per minute, with a volume of 1,054,944,000 gals. per 24 hours. According to Mr. Masters, Engineer for the Severn Commissioners, the minimum flow (February, 1898) was 85,000,000 gals. per 24 hours.

The *height*, as will be gathered from the following measurements made at Cherry Orchard Ferry, and kindly furnished to us by the Borough Surveyor, shows very considerable variations depending upon the rainfall:—

TABLE showing Seasonal Variations in Height of River.

	Ft.	ins.		Ft.	ins.
) November 1899	10	3	31 May 1900	2	2
5 ,, ,,	5	5	11 July ,,	1	8
3 ,, ,,	3	10	14 August 1900	3	5
January 1900	9	5	25 September 1900	1	5
February ,,	5	3	16 October ,,	4	0
March ,,	3	3	6 December ,,	10	8
) ,, ,,	3	5	19 February 1901	3	10
April ,,	3	0	26 March ,,	3	4
May ,,	3	1	27 ,, ,,	3	3

The *streams* entering the Severn are comparatively w. Between the County Asylum and Shrewsbury ere are none. Above the English Bridge the Rea rook, into which some sewers open, mixes its very dirty water with that of the river. With this exception, the brooks and rivulets are all, as the analyses show, comparatively clean, especially those above Cressage, viz., overflow from Sundorne Pool, near Uf-

fington; River Tern and Bell Brook, below Atcham; Cound Brook, above Cound. Below Cressage the following streams enter, viz., Sheinton Brook, Mary's Dingle Brook, "Abbey" Brook, and Hungerdale Brook. These have rather more evidence of contamination. The River Tern and Cound Brook are the only ones of considerable size.

The *land drains* are very numerous on each bank, and many of them have been examined.

THE BANKS OF THE RIVER.

Except along certain parts of the river as it flows through the town of Shrewsbury, the banks are for the most part composed of mud in which willows are numerous. The banks of the river immediately above the waterworks, and also lower down as the river winds through the town, are composed of dust-bin rubbish, which gives to an otherwise pretty river a most dirty appearance, and must be a source of considerable contamination.

THE BED OF THE RIVER.

In the neighbourhood of Shrewsbury the bed of the river is in places composed of sludge, above and below it consists of gravel or rocks. The rocky bottom gives a foothold to a very extensive growth of the Water Ranunculus.

THE SOURCES OF POLLUTION.

The Severn, in the 26 miles stretch which we have examined, affords a typical example of the way in which a beautiful river is polluted and becoming destroyed owing to the carelessness and want of knowledge of the people dwelling upon its banks.

The town of Shrewsbury draws the water which is used for domestic purposes* and which is supplied to the houses directly from the river without filtration. The intake is at a point where the river has already commenced to flow through the town; a few hundred yards lower down the town pours out, through one very large sewer and numerous smaller ones, the crude sewage of 28,396 inhabitants. As the appended map shows, there are altogether in Shrewsbury some thirty-six sewer outlets. When we commenced our investgations we were informed that there were no sources of pollution above the waterworks intake, but two miles higher up we discovered a large sewer pouring the sewage of the County Asylum, and probably of houses, into the stream. Around the outfall of this sewer, as will be gathered from one of the photographs, solid fæces could be seen floating in large quantity, and on some occasions we traced the lumps in the river as far as Shrewsbury. The bed of the river immediately around consisted of putrefying sludge.

For half a mile above the intake there are numerous houses on or close to the banks, and from many of these drain pipes of various kinds can be seen, and as previously mentioned, the banks are little else in places than dust-bin accumulations. Whilst the river passes through the town it receives, in addition to the sewage, all kinds of garbage thrown into it by those living along the banks; it also receives waste from a brewery, and from a candle factory. Thus, during the three miles of its winding course through the town it is subjected at innumerable points to contamination. From Castle Fields Ferry, which is about 2¾ miles below the waterworks, down to Uffington, 4·75 miles, there are no large sources of pollution, and the pollution at Uffington itself appears to be very small.

Lower down, at a point 10 miles from the waterworks, a large sewer enters the river; it carries the sewage of the Atcham Union Workhouse.

The little village of Cound, 3 miles further down, does not affect the river; nor at Cressage, 16 miles from the waterworks by river, although only 8 miles by road, does there appear to be any but the smallest direct inflow of impure water. From Cressage to Ironbridge is 8 miles by water, and Ironbridge is the first town on the river after Shrewsbury.

The sewage of Ironbridge and Coalbrookdale together make the river exceedingly dirty. In Ironbridge itself a multitude of sewers and drains can be seen opening either directly on to the bank or carried for a few yards beneath the surface of the water. The condition of the banks is even worse than at Shrewsbury.

In 1896 the normal dry weather flow of sewage of Shrewsbury was estimated at 844,000 gallons per 24 hours, so that the total sewage entering the river from the town may ordinarily be taken as about 1 per cent. of the volume of the stream; in dry weather the proportion of sewage would be greater.

NATURE OF THE SEWAGE.

The sewage is domestic and composed of slopwaste, fæces, paper and vegetable debris. When it reaches the river through the numerous outlets the solids and refuse are for the most part well broken down; still, a very considerable amount of the lighter fæces and pieces of disintegrated paper may be traced, as will be described further on, floating for considerable distances down stream.

Bacteriological analysis of the sewage from one of the large sewers shows that the number of bacillus coli, viz.: 300,000 per c.c., is what might be expected in a domestic sewage. Analysis of the Atcham Workhouse sewer showed on one occasion 19,000 B. coli per c.c.

EFFECT OF THE SEWAGE UPON THE BANKS, BED AND WATER OF THE RIVER.

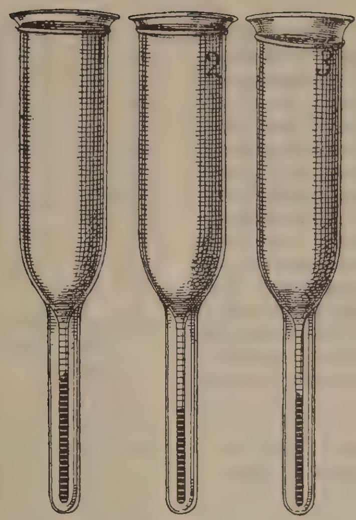
The clearness of the river varies according to the degrees of flood. This is seen from the following summary made from observations above the town of Shrewsbury and therefore before the admixture of sewage.

		Ft.	ins.
15 November 1899	Clear, no recent rise	5	5
18 " "	Clear and falling	3	10
11 January 1900	Muddy, flood	9	5
1 February "	Muddy	5	3
14 March "	Clear	3	3
30 " "	Slightly muddy	3	5
12 April "	Muddy, higher	3	5
26 " "	Clear	3	0
31 May "	"	2	2
11 July "	"	1	8
14 August "	Muddy	3	5
25 September "	Clear	1	5
18 October "	Muddy	4	0
7 December "	"	10	8

The turbidity in the above cases is due to fine mud in suspension. When the river is undisturbed the water is clear, but has the characteristic dark brown colour of water rising in a peaty watershed.

However clear the water may be above the town of Shrewsbury, the sewage of the latter place, when it reaches it, renders it turbid for a considerable distance. We have endeavoured to measure the degree of turbidity by centrifugalising a certain quantity of the water from different points and reading off the amount of solids.

* There are stand pipes in the streets which supply drinking water, which is brought from a distance, and is not derived from the river.



The Tubes employed for the centrifugal experiments.

SOLID MATTER IN SUSPENSION AND METHOD OF ASCERTAINING THEIR AMOUNT BY CENTRIFUGALISATION.

The object was to record by a simple method the increase of solids in suspension in the river which the sewage gave rise to. There is no doubt that these solids gradually settle at the bottom of the river or are thrown down upon the banks, and that they gradually form deposits. Owing to their nature they afford a nidus for putrefaction and tend to support pathogenic bacteria. The method which we adopted was very simple. A sample of water was collected by immersing a bottle below the surface of the river starting from one bank and then rowing across to the other bank in order that the sample might fairly be taken as representing a cross section of the river. 600 c.c. of the sample were centrifugalised, and the supernatant clear fluid was for the most part carefully pipetted off and the deposit together with what remained of the supernatant fluid (about 10 c.c.) transferred to a specially constructed centrifuge tube. We give a drawing of the tubes; the bottom is drawn out like a thermometer stem and graduated. The whole tube holds 10 c.c. and the graduations are definite fractions of 1 c.c. The glass is filled and centrifugalised for 2½ minutes in a hand centrifuge, making about 2,000 revolutions per minute; the result is that the deposit is forced into the graduated stem and the amount can be easily read off.

The following figures show that comparing the river at Ferry III., that is after it has received all the sewage of Shrewsbury, with the river from above the Asylum, that is before any great pollution, there is a substantial increase in solids and that although a decrease takes place from Ferry III. onwards, yet the original degree of freedom from solids is not even reached at Atcham, 11 miles, or Cressage, 18 miles further down. We shall find that the increase of solids is accompanied by similar increase in B. coli both in the mud of the banks and the bed of the river and in the water.

TABLE showing amount of Suspended Solids in 600 c. c. of River Water.

———	Above Asylum, Starting Point.	Ferry III., 4·5 Miles.	Uffington, 6·75 Miles.	Atcham, 11 Miles.	Cressage, 18 Miles.
	Parts.	Parts.	Parts.	Parts.	Parts.
River, 1 ft. 5 ins., very low, clear (25 September 1900).	2	5	4·5	3	5
River, 4 ft., muddy - - - - (18 October 1900).	6	7	7	10	10
River, 10 ft., muddy - - - - (7 December 1900).	10	13	11	11	7
River, 3 ft. 10 ins. on 19th - - (18 February 1901).	4·5	7	6	3·7	5·5
Averages - - -	5·5	8	7	6·9	6·8

FLOATING MATTER AND EXPERIMENTS TO DETERMINE THE EFFECT OF CURRENTS UPON IT.

In addition to the turbidity imparted to the river by the sewage, pieces of macerated paper, floating debris and solid fæces, can be traced, as previously mentioned, for considerable distances. Fæcal matter is encountered collecting in recesses and bays on both banks of the river, nearly as far as Atcham. The collections of obvious sewage material along the banks of the river, and especially at certain spots, caused us to make a series of experiments to ascertain the direction in which the currents in the river were likely to take the suspended matter. Experiments were made by throwing coloured corks into the river some 12 to 15 hours before we rowed down for the purpose of taking water samples. In the first experiment the corks were thrown over the Welsh Bridge. On the following morning a few were seen to be still floating against one of the piers, being kept there by the eddies around the stonework. Elsewhere the corks had formed into groups along the banks in certain definite places. In the second experiment a much larger number of corks was thrown in, and they were found to have collected in the same places. Comparatively few remained in the stream. When thrown in at Shrewsbury no cork was seen further than four miles down on the following day; but when thrown in at Cressage there seemed to be less tendency to accumulate on the banks; many were seen in midstream, and the last one was observed at Ironbridge, eight miles below Cressage. Some may have got further, but the observation was stopped at Ironbridge. Corks were observed in the river and on the banks between Shrewsbury and Atcham, not only a fortnight and two months, but even six months after they had been thrown in; probably washed off the banks at the time the river was in flood. In the series of diagrams and photographs appended, these collections of corks are shown and indicate clearly where the solids in suspension tend to accumulate.

Investigation of the banks at these places showed that the mud was much blacker than elsewhere, and that the willows had strained out a considerable quantity of the floating material. It seems clear that most of the floating matter does not travel far along a winding stream, the banks, with their bays and willows, acting as catchpools and strainers. These are places which seriously detract from the appearance of the river and may become offensive by reason of the decomposition going on there. The changes which take place and lead to the destruction of this solid matter are similar to those taking place on a sewage farm or in aerobic contact beds. Examination of the mud at these places shows that the bacteria are more numerous, and that the bacillus coli is more abundant than elsewhere. In other words, these spots become secondary sources of pollution and danger.

THE EFFECT OF POLLUTION UPON THE BACTERIA OF THE MUD OF THE BANKS OF THE RIVER.

Thirty-two samples of mud taken at various points on the banks of the river from 20 yards above the asylum to Ironbridge, 28 miles lower down, have been examined for B. coli and B. enteritidis sporogenes. The mud was taken in sterilised bottles at the level of the water in the river. The figures which are appended (*see* Table XXVII.) show that whereas the mud above the asylum contained only 25 and 43 B. coli per c.c., the mud taken at various points along the river to Ironbridge showed abundant evidence of pollution ; in the vicinity of Shrewsbury over 100,000 B. coli were obtained in many places, and the number reached an especially high figure in the stagnant bays (432,200). From some distance above Cressage onwards to Ironbridge the B. coli was not found in 1-100th of a gramme. These analyses prove that the mud of the banks is seriously contaminated for a considerable distance below Shrewsbury (18 miles), and that some places are more highly contaminated than others.

THE EFFECT OF POLLUTION UPON THE BED OF THE RIVER AND METHODS OF ASCERTAINING IT.

The harmful changes induced in the bed of a river as the result of the entry of the sewage are well brought out in our observations. The solids in suspension tend gradually to fall to the bottom, and as time goes on they must form a considerable layer. If the water were still the deposit would be fairly uniform, as one of us (Professor Boyce) has demonstrated in the case of Lake Vyrnwy, but the velocity of the River Severn is always tending to extend the deposit further down the stream by shifting it from place to place. Our observations showed us that we found in Shrewsbury a less uniform deposit than we had anticipated, but they also revealed great accumulations.

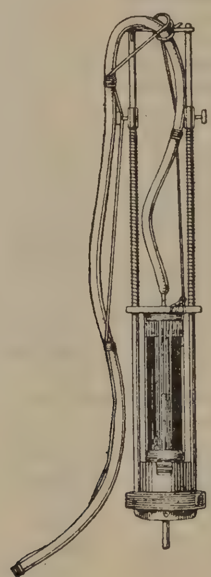


Figure of the Apparatus employed for taking samples o mud from bottom of the River.

It was apparent to the Commissioners that it was of great importance to ascertain the changes going on in the bed of the river, because it was obvious that accumulations might occur, and that these might form concealed foci for the spread of infection. We therefore devised a simple apparatus whereby we were enabled to pump with ease and accuracy into a receiver a sample of the bottom at any desirable place. The figure above of the apparatus explains its construction. A very thick india-rubber tube (pressure tubing) is attached to a glass cylinder, into which a brass tube projects for three inches. The glass cylinder is clamped in a special metal case, which is heavily weighted with lead. To the other end of the pressure tubing a small exhaust pump is attached. When it is desired to take a sample the cylinder is lowered until the latter, with its projecting brass tube is in the mud ; a few strokes of the pump readily fills the cylinder, and the apparatus is drawn to the surface. The deposit cannot fall out because of the projection of the tube in the interior of the glass cylinder. With this apparatus we have made a thorough examination of the bed of the river. We find that, as might be expected, there are great accumulations of decomposing sludge opposite the mouths of the large sewers. When the weighted cylinder presses on these filth accumulations, gas rises to the surface. The deposit around the mouth of the main sewer just below the waterworks extends for a considerable distance on each side and in front of the mouth. As the river passes through Shrewsbury and at those places where the water is shallow and the current swift, the bottom appears fairly clean, but in the deep parts, and especially at one spot just above the English bridge, the river broadens into a large pool of very considerable depth (21ft.) through which the movement of the water is slow. Here a considerable accumulation of fine sludge had collected and gas was evolved.

To estimate the number of bacillus coli in the samples taken from the bottom, the liquid mud, which was brought to the surface, was shaken up and 10 c.c. were measured out in a small cylindrical measure and weighed. The mud was allowed to settle and the proportion between mud and water ascertained. From these data the weight of mud in 1 c.c. of the shaken mixture was calculated. When the mud had settled to the bottom of the measure the supernatant water was considered to contain the washings of the mud. 1 c.c. of this mixture was taken and diluted with sterile water so as to form a dilution of 1 to 100 of the mud. This dilution was plated in taurocholate lactose agar, 1 c.c. being put into each plate, incubated at 42°C. for 48 hours and counted.

The results of the analyses agree in showing an immense increase of pollution in Shrewsbury. Above the Asylum the mud contained 70 B. coli per grm., opposite the first large sewer entering the river, the number was 300,000, a little lower 1,200,000, and in the large deep pool previously mentioned, and situated above the English bridge 44,000. By Ferry III., which is at the end of the town, the number had dropped to 5,200 and 900. Below this point the analyses opposite Uffington 6·75 miles, and Cressage 18 miles, show that the bed has not regained the condition it was in before the pollution.

These observations taken in conjunction with the analyses of the mud of the banks and the amount of

solids in suspension, show that highly polluted material is deposited for several miles along the river, and that in some places there are great accumulations. The gradual contamination of the banks and bed of the river as shown by the B. coli readings, will tend to foster putrefactive and intestinal bacteria, and to increase the pollution of the river. In flood time the loose accumulation of putrefactive material must tend to get displaced, and to get carried further down, and thus the harmful action of the sewage gradually extends.

If the banks of the river, as previously described, act as storehouses for the maintenance and gradual distribution of infected material, these deposits around the mouths of the large sewers and in the deep stagnant pools, are yet more harmful, since they are less disturbed than the banks by the scouring action of the river in flood. The deposits of suspended matter interfere with the growth of the aquatic plants; where the deposit is at all abundant there is no growth, this only making its appearance in the more shallow well-aerated parts of the river. The absence of a clean bottom, supporting weeds, will most probably act injuriously upon fish life.

We have compared the destruction of the organic matter taking place along the banks to the similar process taking place in a contact bed, similarly there is no doubt that the fermentation action taking place at certain parts of the bed of the river is strictly comparable to septic tank action. The inhabitants of Shrewsbury, as of many other places, have relied on their river to treat their sewage. There is no doubt of the deleterious effect of doing so in the neighbourhood of Shrewsbury, as shown by the appearance of the banks and the bacteriological condition of the mud of the banks and bed.

What are the effects upon the bacteria contained in the sewage both as regards the total number and the special bacteria, as those of the coli group, when the sewage undergoes, as that of Shrewsbury does, some dilution, and how far down the stream the sewage bacteria can be traced? In other words, how soon does the river, which is dilute sewage at certain spots, come back to the condition of an effluent which might be used for drinking purposes. These points will be dealt with in the following pages.

THE WATER ANALYSES.

PLACES WHERE THE SAMPLES OF WATER WERE TAKEN FOR ANALYSES.

In choosing sites for taking samples it was obviously necessary to take them above the source of contamination, at various points in and beyond, and as far as possible below the area of pollution. We do not think that there is any serious source of pollution above the "Asylum sewer," until Welshpool is reached, some twenty miles higher up. The first sample was consequently taken about 100 yards above the sewer outfall, and another about the same distance below.

Four points in the town were selected: (1) At the waterworks intake, (2) "Ferry I." at the Quarry, (3) just below the English bridge, viz., after the large contamination caused by Rea Brook, (4) "Ferry III." at Castle Fields, the lowest limit of houses on the bank; within these four points, which are on the lower loop of the above-mentioned S, all the town sewers (with one exception), 36 in number, enter. The other places selected further down the river, were Uffington, Atcham, Cound, and Cressage, and on three occasions, Buildwas and Ironbridge.

Sometimes samples were taken at other places, and in a few instances both above and below small villages like Uffington, etc., to determine whether they had any effect. The names and positions of the other places are given on the tables. The standard places are as follows:—

Distance from Waterworks. Miles.	Name of Place.
2	Above Asylum sewer outfall, 20 yds.
2	Below " "
—	Waterworks.
0·6	Ferry I.
1·6	English Bridge.
2·5	Ferry III.
4·75	Uffington.
9	Atcham.
13	Cound.
16	Cressage.
21·5	Buildwas.
23·5	Ironbridge.

The method of collecting the samples of water from time to time has varied. On three occasions in November, 1899, the samples were taken from ferries or bridges. Only one sample was taken at any one point, and, although three were taken across the river, viz., midstream, right and left banks, these were not mixed, but were analysed separately.

From January, 1900, onwards the samples were taken from a boat, usually in midstream about 2ft. 6in. below the surface of the water. From April onwards six or more of these "deep" samples were collected at any cross section of the river and mixed, and the mixed sample analysed. At the same time a midstream sample was also taken and separately analysed for comparison. In July and afterwards both superficial and deep cross section samples were taken. On the last two occasions both superficial and deep samples were taken simultaneously. Prior to that it was necessary to row twice across the river, and in consequence the samples may not be strictly comparable. In any case it may be doubted whether the results are so trustworthy as a midstream sample, because it is practically impossible to avoid a disturbance of the river bed when getting near the shore.

When first the boat experiments were started it was thought necessary simply to let it drift in order to obtain concordant results, but it was soon seen that this was not really necessary nor practicable, because the boat does not drift so fast as the lighter suspended solids, and it would have extended the experiment through the night (not a very safe proceeding or a shallow river like the Severn), and delayed the examination of the samples.

Only one analysis has as yet been made of the water taken from one place (Cressage Bridge) at definite intervals during the day.

The small bottles used for collecting were kept in an icebox until our return to the laboratory in Liverpool, the same evening, when they were put into the refrigerator room and kept there until the time of examination on the following morning.

METHODS OF BACTERIOLOGICAL ANALYSIS EMPLOYED.

The object of the analyses was to ascertain the total number of bacteria present, the number of the bacillus coli group and the presence or absence of the bacillus enteritidis sporogenes. To ascertain the former numbers, Petri dish cultivations were made. The media used consisted of standardised gelatine, and carbol and bile salt agar. The carbol agar was carefully prepared, and of such strength that when 1 c.c. of the water to be analysed was added to 9 c.c. of the carbol agar the strength of the carbolic acid was 1 in 1,000. This strength Miss Chick had determined by a lengthy series of experiments, published in the Thompson Yates Reports, to be best adapted for isolating the B. coli group. With this strength of carbolic acid a very large proportion of the common putrefactive bacteria were inhibited, so permitting of the more ready identification of the coli group. Later on in the experiments the carbol medium was replaced by Taurocholate Lactose Agar.

The composition and advantages of this medium for the detection of the B. coli and typhoid baccilli have been separately reported upon to the Commissioners, and need not again be detailed. Previous to making an analysis the bottle containing the sample was carefully shaken, and 1 cubic centimetre, or a definite dilution of this (1 in 10, 1 in 100, 1 in 1,000, etc.), added to the liquefied gelatine and agar tubes. In the case of gelatine, six Petri dish cultivations were made, in the case of agar three. The former were incubated at 20° C., and examined from time to time till they showed the maximum number of colonies. The agar plates were incubated at 42° C., and first observed at the end of 48 hours.

To determine the presence of the B. enteritidis sporogenes, freshly prepared sterilised milk tubes were used. When the water to be examined, either undiluted or diluted in the proper dilution, had been added to them they were exposed for 15 minutes to 80° C. in a water bath, and then incubated at 37° C. with anaerobic precautions.

Owing to the large number of analyses made, and the uniformity of the media, the figures which we have obtained are as accurate as these forms of analysis can be.

Examination was also made for special bacteria such as thermotletic and H_2S forming bacteria; for the cultivation of the latter ferro-gelatine was used.

THE BACTERIOLOGICAL ANALYSES OF THE RIVER SEVERN ABOVE THE SOURCES OF POLLUTION AND OF THE LAND DRAINS AND STREAMS ENTERING IT.

One of the large tributaries in Wales which go to form the River Severn is the River Vyrnwy.* The watershed of this river has been formed into a very large artificial lake by means of a dam, but a regular flow of water from the lake, known as "compensation water," is allowed to flow away, in order to maintain the River Vyrnwy in the condition it was before the construction of the lake. The lake is one of the main water supplies for Liverpool, the water being first carried to Oswestry, where it is filtered. This lake and the numerous streams entering it, as well as the soil of the watershed and the mud which settles to the bottom of the lake, are constantly under observation. The analyses are made regularly for the Corporation of Liverpool by one of us (Professor Boyce). The comparison of the results of the analyses of the unpolluted Vyrnwy watershed and of the polluted Severn lower down are very striking, and clearly demonstrates the value of the bacteriological analysis, and of the importance of the B. coli as a test of intestinal contamination. The following is a summary of the results on the watershed.

Streams of Lake Vyrnwy Watershed.

Thirty-eight streams entering the lake were most carefully analysed by Miss Chick † for the presence of the B. coli. The latter was found only in one case present in 1 c.c., and in this case "there was a gang of men working close to this stream on this date." In two other cases it was present in a less proportion than one B. coli per c.c., and here again, owing to proximity to farms, there was probability of contamination.

Samples of Soil of Watershed.

Fifteen samples of soil were analysed by Miss Chick. "One gramme of soil was weighed into a sterile flask, 10 c.c. of sterile water were added in some cases, and 50 c.c. in others. The whole was then thoroughly well shaken, and 1 c.c. taken and 3 plates poured." The B. coli was absent in the quantities taken, viz., 0·1 grm. and 0·02 grm.

Water of the Lake.

The water has been repeatedly analysed for the past three years, and one cubic centimetre has been found free from B. coli. Larger quantities have, however, been shown by Miss Chick to contain this organism in small numbers. The average number of bacteria, as determined at different points on the surface, and at various depths in the lake is 31 per c.c.

Deposit on the Bottom of the Lake.

A thorough examination of the bottom of the lake has been recently made by us with the apparatus previously described. In all, 28 samples of mud were brought to the surface from depths varying from a few feet to 70 ft. The method of analysis consisted in adding ·5 c.c. of the mud to two taurocholate lactose agar tubes, and making two Petri dish determinations. The investigation showed that in the comparatively large sample of mud taken from very numerous points in the bottom of the lake, the bacillus coli was found in three samples and then only one colony was present in each case; thus bearing out the preceding statements with regard to the absence of the B. coli from the streams, and from the lake of the Vyrnwy watershed.

The Bacteria of the Land Drains and Small Streams entering the Severn between Shrewsbury and Cressage (18 Miles).

We found numerous land drains entering the river between the Asylum (Shrewsbury) and Cressage. The water of these, with one exception, viz., the Atcham Workhouse sewer, was perfectly clear. Seventeen of these have been examined for the B. coli by the carbol agar method by Miss Chick.

In twelve cases the B. coli was absent in 1 c.c. Where present it was only in small numbers, and in these cases contamination might be suspected from their proximity to houses. The comparative freedom of land drains from B. coli is a most noteworthy fact, and demonstrates that these small tributaries are harmless unless they receive sewage.

The analysis of one particular small land drain proved in a remarkable manner the truth of this statement. As many as 19,000 B. coli per c.c. were found in it; we then traced it back from the river, and observed that it received the sewage of the Atcham Workhouse, we also discovered the other unmistakable sign of sewage pollution in it, viz., the presence of abundant growths of Sphaerotilus natans. The total number of bacteria per c.c. in these drains varies between 100 and 3,000, and this is what might be expected from the absence of the *B. Coli.*

In addition to the land drains an investigation was made of the small brooks entering the river. A table is appended showing that 17 analyses were made (Table XXV.). It will be seen that the total number of bacteria are greater, and that the bacillus coli was usually present, the average being 24 per c.c. From the position of these brooks we concluded that they must all have been contaminated.

The Bacteria of the Severn immediately above Shrewsbury.

The samples were taken about 20 yards above the county asylum sewer outfall, and therefore 2 miles above Shrewsbury. A table is given showing the result of bacteriological analyses extending over one year. The total number of bacteria appears to vary considerably, the average working out at 10,000 per c.c., but if certain very abnormally large enumerations were left out, and which appear exceptional, the average would not exceed 5,000 per c.c. The bacillus coli is usually present, but only in small numbers, the average being 11 per c.c. The bacteriological state of this part of the river, which here is about 180ft. broad, is better than the small brooks entering it, and this is what would be expected, because the river starts with a considerable volume of unpolluted water.

SUMMARY OF THE RESULTS OF THE BACTERIOLOGICAL ANALYSES OF THE RIVER SEVERN AND TRIBUTARIES PREVIOUS TO POLLUTION.

Commencing with the watershed the numerous analyses which have been conducted during the past three years show that the B. coli is absent in the proportion of 1 per c.c. in the feeders of the River Vyrnwy. An extensive analysis of the mud of the lake, and of the soil of the watershed also shows the absence of the B. coli. The watershed is the property of the Liverpool Corporation and is carefully protected from pollution, and the results show that in the absence of fæcal contamination there is no B. coli.

Next proceeding to the Shrewsbury district which is not under control in the same manner as the watershed, we find that the numerous small brooks which enter the Severn reveal evidence of definite contamination, but that the land drains, the water of which is probably subjected to some slight degrees of filtration, are comparatively free from pollution. This is very interesting for undoubtedly the brooks are liable as they pass close to human habitations to contamination; whilst the land drains, removing the water from pasture and arable land are isolated. Lastly, taking the River Severn itself above the great source of pollution which occurs at Shrewsbury, we find that B. coli is present in the proportion of about 10 per c.c. Between Vyrnwy and Shrewsbury there is a gradual contamination, every brook which contributes to the volume of the Severn as it passes through the more thickly peopled districts, adds a small number of B. coli, and at certain places like Welshpool there is considerable direct contamination. No wonder then that already above the waterworks intake at Shrewsbury there is distinct evidence of sewage pollution. Thus the streams of the watershed may be taken as the standard of purity and as furnishing water which is harmless to drink; that of the Severn above Shrewsbury as slightly polluted, and as water which should be subjected to filtration before being consumed. It remains now to see what is the effect of turning the sewage of Shrewsbury into the

* One of us (Professor Boyce) has rowed down the Severn from Welshpool, which is the first navigable point on the river, and which is between 50 and 60 miles above Shrewsbury by river. There is marked coli pollution at Welshpool, and this gradually disappears.

† The distribution of the B. coli. Harriette Chick B.Sc. Thompson Yates Reports, Volume III. Part I., 1900.

already slightly polluted river, and how far it differs bacteriologically from the standard in the watershed after it has been polluted, and further after what distance it regains its original degree of purity.

EFFECT OF THE POLLUTION OF SHREWSBURY UPON THE WATER OF THE RIVER SEVERN.

As stated earlier in this report the places where the samples were taken for analysis were as follows:—

1. Opposite the County Asylum, that is a point 2 miles above the Shrewsbury Waterworks.

2. Opposite the Waterworks intake, which is situated just inside the town of Shrewsbury.

3. At "Ferry I." (Quarry Ferry), 0·6 of a mile lower down.

4. At English Bridge, 1·6 miles from the Waterworks.

5. At "Ferry III." (Cherry Orchard Ferry), 2·5 miles from the Waterworks. This point marks the end of the town of Shrewsbury, the polluting area being comprised between the Waterworks and this point.

6. Uffington, a village 4·75 miles below the Waterworks.

7. Atcham, a village 9 miles from the Waterworks.

8. Cound, a few houses, 13 miles from the Waterworks.

9. Cressage, a village 16 miles from the Waterworks, or 18 miles from the starting point.

Occasionally samples were taken at the village of Buildwas 21·5 miles from the Waterworks, and Ironbridge a town 23·5 miles from the same point.

It is not necessary to repeat the methods of analysis we employed, these will be found in the commencement of the report. Those who are practically acquainted with river analyses will know the difficulties of obtaining strictly accurate results. By repeating our analyses and by making several analyses from each sample, and by always keeping the samples on ice we believe that our results give a very true picture of what is happening bacteriologically in the river.

THE TIME OF THE YEAR WHEN THE ANALYSES WERE MADE.

The first analyses were made in the month of November, 1899, others in January, March, April, May, July, August, September, October, November, and December in 1900, and a few in February and March of this year 1901. The analyses have therefore been made throughout one whole year, in spring, summer, autumn, and winter, and in all conditions of the weather, and with the river at its highest and lowest levels.

OBJECT OF THE BACTERIOLOGICAL ANALYSES.

To determine the total number of bacteria per c.c., the number of the bacillus coli communis and the proportion of the bacillus enteritidis sporogenes as measured by its spores. Numerous determinations were made of the number of thermophilic bacteria present. The general bacterial flora of the river was also investigated.

RESULTS.

Two series of tables are appended to this report; in one series the analyses are grouped under the place where each observation was made (Tables I.-VIII.); in the other series of the analyses of the stretch of river examined on a given date are recorded (Tables IX.-XXIV.).

In order to render the tables more intelligible graphic charts have been prepared which show at a glance the bacterial state of the river in the various months of the year as well as the average.

I.—TOTAL NUMBER OF BACTERIA (ROUND NUMBERS).

At Asylum *	the average is	7,000 per cc.	0	miles.
„ Waterworks	„	13,000 „	2	„
„ Ferry I.	„	20,000 „	2·6	„
„ English Bridge	„	23,000 „	3·6	„
„ Ferry III.	„	19,000 „	4·5	„
„ Uffington	„	17,000 „	6·75	„
„ Atcham	„	13,000 „	11	„
„ Cressage	„	5,000 „	18	„

A glance at these figures and at the large charts (Charts I. and II.) shows that the effect of contamination is unmistakable. Already before the Waterworks are reached the numbers have increased, owing to the pollution which was pointed out to occur for some distance above the Waterworks intake.

In the midst of the pollution at English Bridge the number of bacteria has reached a maximum; they are more than three times more numerous than at the start. From Ferry III., that is the end of Shrewsbury, there is a gradual drop for two miles below this point, for at Uffington the number is 17,000, and at Atcham six miles further down the number is 13,000, finally at Cressage, 13 miles below the last source of town sewage contamination, the number is even lower than that at the Asylum above Shrewsbury.*

At first sight the results might appear remarkable. The effect of pollution as measured by the total number of bacteria does not appear so large as might have been anticipated, knowing as we do that all the sewage of a town of some 28,000 inhabitants enters the river and that the average number of bacteria per c.c. in such sewage is about 3 millions.

Dilution is the cause of this large reduction; the volume of the River Severn is more than 100 times greater than that of the sewage entering it and the effect of this is to reduce the numbers to a figure on the average below 30,000 per c.c. The other remarkable feature is that the bacteria are not carried down so far as might be expected, for at least at Cressage 13 miles from Shrewsbury it cannot be said that the effect of the sewage can be measured by the total number of bacteria present in the water. These observations are in accord with those of other investigators, as will be seen from the table appended, showing the results of analyses of some rivers on the Continent (Table XXX., p. 14).

II.—TOTAL NUMBER OF BACILLUS COLI.

Our investigations have in the main differed from those of previous investigators in the attention which we have directed to ascertaining the numbers of this micro-organism both in the water and in the mud of the banks and bed of the river. As previously pointed out, we have, as the result of our own investigations, come to the conclusion that this organism is a most accurate measure of intestinal pollution, and that far greater information as regards the effects of sewage pollution can be gathered by its estimation than by simply counting the total number of organisms present. We know a great deal more of the B. coli than of the innumerable other bacteria which are found in water and in sewage, and which from various causes may undergo considerable fluctuations in their numbers in their course down stream. The Bacillus coli is an intestinal parasite, and away from the intestine it is not, in the great majority of cases, in a suitable medium for its multiplication, and tends to perish, and therefore if it is found it has not been long absent from the intestine.

The average figures obtained are as follows:—

	B. Coli.		
At Asylum	13 per cc.	0	miles.
„ Waterworks	46 „	2	„
„ Ferry I.	177 „	2·6	„
„ English Bridge	321 „	3·6	„
„ Ferry III.	600 „	4·5	„
„ Uffington	142 „	6·75	„
„ Atcham	48 „	11	„
„ Cressage	36 „	18	„

These figures and the chart (Chart II.) made from them show more strikingly than the preceding enumerations the effect of pollution and the distance at which the pollution is felt.

As in the case of total numbers so here there is a slight increase at the waterworks, and from thence a rapid increase takes place for the three miles the river winds through Shrewsbury to Ferry III. At this point the average number of B. coli per c.c. is 600, or 46 times greater than in the water above Shrewsbury, whilst as seen in the case of the quantitative analyses the maximum average was only three times greater than in the unpolluted water. The maximum effect of pollution occurs at the end of the town, where one would expect it to be. Two miles further down (Uffington) the

* It is highly probable that this average is misleading, for, with one exception, on each day when samples were taken both at the Asylum and at Cressage, the numbers at the former spot were much lower than at the latter.

number has dropped very considerably; at 6 miles (Atcham) the number is 48, and at the 13 miles point (Cressage) the number is 36 per c.c.

As the result of allowing the sewage of Shrewsbury to enter the river, there is at once nearly a fiftyfold increase in the numbers of this intestinal parasite, and a river which two miles higher up (at the Asylum) only contained a few to the cubic centimetre, and still higher up in the unpolluted sources in Wales contained none to the cubic centimetre, now contains upon an average 600 per c.c. But here again a larger number of B. coli might have at first sight been expected, but when it is remembered that the average number of B. coli in sewage varies between 50,000 and 100,000 per c.c., and that the sewage becomes diluted at least 100 times, the above figures appear correct. After the pollution ceases the number of B. coli falls very considerably, showing that there is no multiplication, but even at Cressage, 13 miles lower down, the effect of the sewage of Shrewsbury can be distinctly seen. Our observations, indeed, lead us to the conclusion that the effect of Shrewsbury pollution has not had time to disappear before another town, viz., Ironbridge, pours its sewage into the river. It is in this way that rivers become gradually polluted from source to mouth, and that a river eminently potable at its commencement, becomes unfit for drinking purposes lower down.

The analyses show that there is no evidence of the multiplication of the B. coli in the water. These organisms removed from their most favourable environment in the animal body find conditions in the river unsuitable to their multiplication, and they probably perish in considerable numbers as they pass down stream. But most probably the greatest cause of their removal is sedimentation and adhesion to the mud of the banks.

We have proved their presence in considerable quantities in the mud of the bottom and of the banks. (Tables XXVII. and XXVIII.) Here, however, as already pointed out, although they do not perish immediately, owing probably to the food conditions being more favourable, there does not appear to be any evidence of multiplication. As pointed out in a previous report upon the "Filtration of Sewage Effluents," we could not find any evidence of the multiplication of the B. coli in the body of the sand or earth filters, and we concluded that filtration, and the struggle for existence with the other organisms, and the products of these, and in addition the fact that the physical conditions of temperature, food, etc., were not like those in the alimentary tract, were the causes of their reduction. So in the case of the river, sedimentation, unsuitable environment, and struggle for existence with other organisms help to extinguish it. But these observations teach us that accumulations may gradually occur, and that when the river is disturbed these may considerably augment the numbers, and, further, that even 13 miles below Shrewsbury there is distinct evidence of pollution.

THE SIGNIFICANCE OF THE BACILLUS COLI IN THE RIVER.

It is often argued that the presence of the B. coli is of little significance, because it must be widely distributed in nature, and because it must often be taken internally in water and food stuffs. But we have shown by very numerous analyses that the B. coli is not universally distributed, and that it occurs in foods and water in those cases where pollution might obviously have taken place, and the recent report of the German Commission confirms our conclusions as regards the sudden rise of the B. coli in streams flowing in the neighbourhood of human habitations. Therefore we conclude that in the first place the B. coli serves as a most unmistakable indicator of intestinal pollution, and that as seen from our river experiment the degree of pollution can be accurately measured at any given point. Measuring intestinal pollution, and, moreover, intestinal pollution of recent origin, as we have shown elsewhere, it may be taken as a guide of what would happen to the bacillus typhosus or cholera vibrio if these organisms escaped into the river.

In our Colonies and in India, as previous Commissions have shown, polluted water is a fertile source of cholera, but in this country the danger of drinking impure water arises largely from the presence of the bacillus typhosus. If in the case of the River Severn the B. coli which we have found in such comparatively large numbers after the sewage of Shrewsbury has passed into it was replaced by the B. typhosus, we would unhesitatingly conclude that the organism would be carried very many miles down stream, and that it would collect in the mud of the river. Fortunately, it is never so abundant as the B. coli, a fact which will be readily understood when it is recollected that the proportion of typhoid cases is in most instances comparatively small. It will be seen that in the case of Shrewsbury an epidemic of typhoid which would affect one-sixth of the inhabitants would only lead to the presence of about 100 B. typhosus per c.c. in the river at Shrewsbury, and that although these might be carried down several miles, yet as seen from the B. coli observations the chances of this would be small. There can be no doubt that the great volume of the River Severn thus greatly reduces the risk of the transportation to any distance of the pathogenic organisms. Our observations tend to show that it is the small polluted stream like the Atcham brook, containing perhaps 19,000 B. coli per c.c., and which if drunk or used for washing utensils might very well convey the infection of typhoid. In other words, if the sewage, however small in quantity, that derived, for instance, from only one cottage, enters a very small brook (or percolates into a well), which is drunk within a short distance of the source of contamination, the chances of infection with typhoid, if there was a case of this disease in the house, would be great. These observations, based upon the often far larger proportion of B. coli in small streams than in larger rivers, accords with the experience of typhoid infection through wells.

From what has been said, no doubt ought to exist of the value of the B. coli as a measure of the degree of intestinal pollution, and therefore of the chances of the presence or absence of the B. typhosus. But the presence of the B. coli may itself be harmful. We have found it associated as others have done with outbreaks of diarrhœa and inflammation, and with abscess formation.

The bacillus coli taken in by the mouth may produce serious results. Having before them this fact, the Commissioners asked us to test the pathogenicity of the B. coli, which we isolated. It was found that in the majority of cases the organism was not pathogenic when introduced subcutaneously into the guinea pig.

This is quite in accordance with our knowledge of pathogenic organisms; removed from the animal body they rapidly lose their virulence, but once introduced into the system they may at any moment become pathogenic. If it is satisfactorily established, and we have endeavoured to do so, that the B. coli which is found in the River Severn is derived largely from the B. coli of the intestine of the inhabitants of Shrewsbury, then certainly this organism, when it is taken in by the mouth and reaches the small intestine, may become pathogenic, as Dr. Klein has pointed out in his evidence before the Royal Commission.

NOTE UPON THE DEFINITION OF THE BACILLUS COLI GROUP.

We have considered it necessary in view of criticism of the results which we have obtained with the B. coli to summarise here our investigation of this group.

Numerous organisms have been described, under different names, which really belong to the same family and merely show insignificant variations from the original type. Experience has shown us that these variations are not constant, and consequently are not to be relied upon. Instead, therefore, of attempting to identify with its special variety every organism which we have isolated we have endeavoured to gather them together in groups and to differentiate the groups by reactions which are constant. One example of our method will suffice.

A subculture of the original B. coli communis (Escherich) was obtained and worked out. It had the following biological characteristics.

Morphology.—A non-sporing, slightly motile organism usually short but with many long forms.

It does not liquefy gelatine, and does not stain by Gram's method.

Bile salt-Glucose broth	Acid and gas.
Glucose broth - -	,,
Lactose broth - -	,,
Mannite broth - -	,,
Cane-sugar broth	- No change.
Indol - - -	- Usually present, but not always.
Milk - - -	- Acid and clotting.
Agar and Gelatine	- Moist, whitish, or greyish growth, showing nothing characteristic.

Now the characters which so far have been shown to be constant are :—

(1) The non-formation of spores.

(2) The non-liquefaction of gelatine.

(3) Acid production in milk.

(4) The reactions in the various sugars.

Under the following heads, however, variations do occur :—

1. *Gram's Method.*—As regards the staining by Gram's method, Alexander Schmidt has found that under certain circumstances members of the B. coli group retain Gram's stain. Too much stress must not, therefore, be laid upon the fact that if an organism stains by Gram it cannot be a member of the Coli group.

2. *Milk.*—The coagulation of milk is also somewhat unreliable, as we have isolated organisms which at first coagulated milk, but later did not, and vice versa.

3. *Indol.*—The production of indol is very variable. The same organism will sometimes give the indol reaction, and sometimes fail to give it. The production of indol apparently depends upon some unknown quantity in the broth, and as broth cannot be made of exactly the same composition each time we consider that little importance should be attached to this reaction.

4. *Cane Sugar Broth.*—It will be noticed that the B. coli (Escherich) does not cause any change in this medium. Organisms have been, however, isolated which correspond in all other particulars with B. coli communis (Escherich), but which caused changes in Saccharose broth. Consequently we are at present in doubt as to the real value of this medium.

5. *Motility.*—This is another doubtful point, for the B. Neapolitanus gives the reactions of the group, and yet is, so far as is known, non-motile.

6. *Flagella.*—The *Bacillus coli* (Escherich) has usually 4 to 8 flagella attached all round the organism, but B. C.C. forms have been described with only one terminal flagellum.

For the above reasons then we would for the present define the B. coli communis group as consisting of organisms which have the following characters :—

(1) THEY ARE NON-SPORING AND NON-LIQUEFYING.

(2) THEY RARELY STAIN BY GRAM'S METHOD.

(3) THEY PRODUCE ACID AND GAS WITH BOTH GLUCOSE AND LACTOSE, AND MAY DO SO WITH SACCHAROSE.

(4) THEY PRODUCE ACID IN MILK. AND USUALLY ALSO COAGULATE IT.

(5) THEY PRODUCE ACID AND GAS IN BILE SALT GLUCOSE BROTH.

(6) THEY GROW WELL AT A TEMPERATURE OF 42° C.

We would, therefore, include in the B. coli communis group such organisms as

B. Neapolitanus (Emmerich).

B. Acidi Lactici (Hueppe).

B. Cavicida (Brieger).

B. Capsulatus (Pfeiffer).

Some organisms, such as B. pyogenes fœtidus, give all the reactions of B. coli communis except gas production. The position of these organisms is at present doubtful.

Another group which suggests itself is the "*Gaertner*" *group.*

It includes such organisms as the

B. Enteritidis (Gaertner),

B. Psittacosis (Nocard),

B. Choleræ Suum (Flexner),

and differs from the B. coli communis group in causing no change in lactose or cane sugar, and in not clotting milk, but resembles B. coli communis in its power of producing acid and gas in glucose and mannite media.

A third group is the "*typhoid*" *group*, which produces only acid with glucose and mannite, and does not affect lactose or cane sugar. In milk there is either no change or only a slight acid production.

COMPARISON OF THE TOTAL NUMBER OF BACTERIA WITH THE NUMBERS OF B. COLI.

The proportion of B. coli to the total numbers is well seen in the large chart (Chart I.), where both are figured out on the same scale. This chart shows very clearly that the B. coli forms only a small fraction of the total numbers, and that the increase in numbers is accompanied by a corresponding rise in the Colon bacillus. There are, however, certain small differences of agreement; for instance the total number of organisms is greatest at English Bridge, whilst B. coli is greatest a little further down at Ferry III., and at Cressage the numbers of B. coli have not dropped in the same proportion as the total numbers. (*See* footnote, p. 9.)

SEASONAL VARIATIONS IN THE NUMBERS OF BACTERIA.

The total number of organisms in the river differs according to meteorological conditions. When the weather is dry and warm, and the river low, the numbers are above the average. This is well seen on September 25th, 1900, when the river was at its lowest. On the other hand on January 11th, 1900, the river was high, and the temperature low, and the numbers are decreased. When the river is muddy the total number is somewhat increased. When the river is swollen and the sewage in consequence greatly diluted the number of B. coli is considerably reduced (Charts III. and IV.).

DIFFERENCES BETWEEN SUPERFICIAL AND DEEP SAMPLES.

The differences between the samples collected on the surface and those taken 2ft. below the surface do not appear great. More commonly the superficial contains more bacteria than the deep sample, but in many instances this is reversed.* (Chart V.) We may here point out as an explanation of the irregular rises in numbers which are sometimes noticed, that the presence of a small particle of fæcal or decomposing matter in the water analysed may greatly augment numbers. It is always necessary to repeat observations many times.

THE EFFECT OF CURRENTS UPON THE DISTRIBUTION OF BACTERIA. STAGNANT BAYS.

The cork experiment which we devised showed clearly that floating bodies tend to pass out of the stream and to collect in certain bays and stagnant recesses along the banks. We found the mud of these bays very dirty and containing considerable quantities of the B. coli. Usually the water here presented a scum, and contained very large numbers of bacteria, and on this account in taking our cross section samples of the river we avoided these pockets. We also took numerous samples from the middle of the stream, and close up to the banks, and sometimes the one and sometimes the other contained the larger number of bacteria. From these experiments and from the superficial and deep analyses we concluded that the bacteria in the river showed an irregular distribution, and it was for this reason that in the later observations a series of samples were taken, as described in the early part of this report, at numerous points from bank to bank, and then mixed, and the samples for analysis drawn from the mixed samples. This is a method which we strongly recommend to be carried out in all future analyses of rivers. In the preceding pages attention was drawn to the possible dissemination of bacteria from accumulations of mud and debris in certain bays along the sides of the river; and that this is very probable will be gathered from the fact mentioned above, that the bacteria in the water in these places are very abundant.

B. ENTERITIDIS SPOROGENES (KLEIN).

Considerable importance has been attached to this bacillus by Klein and Houston on account of its supposed causal relation to certain outbreaks of epidemic diarrhœa, its presence in comparatively large numbers in sewage, and its absence from pure water and virgin soil. For these reasons they consider its presence to

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*As the result of an exhaustive investigation in the Rhine, Salomon found as a mean of 176 superficial samples 3,975 colonies per c.c. ; of 192 deep samples, 4,642 cols. per c.c. ; but he also found that the individual analyses were very variable.

indicate previous sewage pollution. The identification of the bacillus is not always easy without recourse to an inoculation experiment, since according to Klein it may be confounded with B. butyricus and B. cadaveris, the main difference lying in its pathogenicity to guinea pigs. If this be so, then it is not such a reliable indicator of sewage contamination as B. coli, for, firstly, it was absent in many samples of the River Severn taken at points where the river was obviously contaminated with sewage and B. coli communis was found; secondly, several of the samples which gave an apparently typical reaction in milk culture were very slightly, if at all, pathogenic. Moreover, from recent investigations by Balfour Stewart and Glynn (Thompson Yates Report, Vol. III.), confirmed in some details by Klein and Houston (L. G. B. Report, 1899-1900), it is evident that this bacillus, pathogenic to guinea pigs, is very widely distributed. Not only did they find it, as previous observers have already done, in the normal and diseased intestine—the normal habitat of B. coli—but also in various foods, cooked and uncooked, in dust, and occasionally in air, *i.e.*, places in which B. coli was practically always absent. It is, therefore, much more widely distributed than B. coli, but this is not surprising, since it has been shown by Miss Chick and others, that drying and sunlight rapidly destroy B. coli, while the more resistent spore-bearing B. enteritidis survives. Consequently without denying that the original habitat of B. enteritidis is the intestine, and that its presence indicates previous pollution, it is evident that we are constantly ingesting it to a far larger extent than B. coli, that it normally occurs in foods in which B. coli is absent, and for these reasons we cannot attribute to it the same diagnostic importance.

As regards its distribution in the River Severn, it has usually been absent when B. coli was absent, namely in the comparatively pure parts of the river, and in some of the land drains entering it; on the other hand it has occasionally been absent also in obviously polluted parts like Cherry Orchard Ferry, so that its distribution forms a most irregular curve.

The method adopted for the detection of B. enteritidis was that originally recommended by Klein, viz., anaerobic cultivation in freshly sterilised milk. It may, however, be added as a matter of general interest, that, no difference could be detected between these and control cultivations made without anaerobic precautions.

In conclusion, although it is of considerable interest to demonstrate the presence of this remarkable spore-bearing anaerobe described by Dr. Klein, yet we do not think that it is necessary to make a routine application of this test, and we note that it has not, so far as we are aware, been employed by continental observers in bacteriological analysis, although known to them for the last four years.

THERMOPHILIC AND THERMOTLETIC BACTERIA.

The bacteriological investigation of the River Severn could hardly be considered complete without some investigation into this class of bacteria, especially since they are usually absent from 1 c.c. of good water, but elsewhere are very widely distributed, although, as a special investigation showed, absent from many foodstuffs. They are always found, in varying numbers, in the River Severn, and although one form seemed especially present in the contaminated area, its distribution was not sufficiently characteristic to be of much use. Most of the forms isolated were non-pathogenic for guinea pigs; one bacillus was pathogenic when grown in milk culture. We do not think in the present state of knowledge that much use can be made of these observations, but they suggest that the presence of thermophilic bacteria in large numbers is to be regarded with suspicion.

The method adopted was simply to make agar plate cultivations with 1 c.c. of water (or less, of sewage), and to incubate at 55°-65° C. Subcultures were then made and examined. Several forms were theremotletic (heat-enduring) rather than thermophilic (heat-preferring), inasmuch as they grow quite as well at 37° C.

THE BACTERIAL FLORA OF THE RIVER SEVERN.

The adjoining table gives in brief the characteristics of 75 organisms isolated from gelatine plates of the water of the River Severn. The samples of water were taken at various points of the river during its passages through and beyond the town of Shrewsbury. Before the untreated sewage of the town enters the river, the most characteristic organisms which occur are the fluorescent liquefying bacilli and chromogenic or non-chromogenic cocci. After the entrance of sewage these tend to disappear, and their place is taken by the common and yellow Porteus forms—types of organisms commonly found in sewage-polluted waters (together with bacilli conforming to the types of B. Ramosus and B. Megaterium).

The most characteristic and the most frequently occurring were isolated from the plates. The classification adapted is that of Professor Marshall Ward in his fifth report to the Water Research Committee of the Royal Society, and one adapted by us in an investigation of the micro-organisms found in the Liverpool waters. (Journal of Path. and Bact., May, 1899.) Considering in detail the adjoining table, the following are the groups, members of which were isolated :—

Group 5. Colourless non-liquefying bacilli, conforming to the type of B. Coli Communis.—Three of these were typical of and gave all the reactions of B. Coli; the fourth, though microscopically identical with the the others, did not act on milk, or ferment glucose, probably an enfeebled form.

Group 6. Common Proteus Type.—This is ver y common—18 organisms were isolated—all act upon milk, lotting and peptonising the casein, some giving an acid, other an alkaline reaction to Litmus. They all form indol in broth, but only a few are capable of fermenting glucose.

Group 7. The Yellow Proteus Type. The members of this group also are found to occur very commonly, and are characterised by rapid clotting and peptonising action in milk, with an acid re-action. The majority give idol in broth, but are not capable of fermenting glucose; they are apparently closely allied to the fluorescent bacilli, from which they are difficult to distinguish.

Groups 9 and 10. Yellow Liquefying and Non-liquefying Bacilli.—7 examples.—Probably a variety of Group 7, which they resemble closely in their reaction.

Group 13. Bacilli producing a crimson pigment.—This type is uncommon—only one example being isolated. It is probably identical with B. prodigiousus.

Group 15. Bacilli conforming to the type of B. Subtilis.—This type is frequently met with, but only two forms were studied in detail.

Group 16. Sacrinæ forming a Yellow Pigment.—This is fairly common; the liquefactive action in gelatine is not constant.

Group 19. Non-chromogenic Micrococci.—These are found to occur very frequently. 19 examples were isolated. Only two of these were capable of acting on litmus milk, producing an acid re-action. Microscopically they were all staphylococci.

Group A. Chromogenic Micrococci.—Fairly common, 7 specimens isolated. Only 2 were capable of changing litmus milk. Their microscopical appearances varied slightly in different specimens.

Group C.—A pure yeast form.

TABLE.

—	No. of Organisms Examined.	Gas formation in Glucose Gelatine.	Action on Milk.	Indol Reaction.	Microscopical Appearance.
Group 5	1	P.	Acid, Clot	P.	Small stout oval Bacillus with rounded ends.
	2	P.	Acid, Clot	P.	,, ,,
	3	A.	No reaction	P.	,, ,,
	4	P.	Acid, Clot	P.	,, ,,
Group 6	1	P.	Acid, Clot, Peptonised	P.	Proteus.
	2	P.	Acid, Clot, Peptonised	P.	,,
	3	A.	Clot, Alk, Peptonised	P.	,,
	4	A.	Clot, Alk, Peptonised	P.	,,
	5	A.	Clot, Alk, Peptonised	P.	,,
	6	A.	Clot, Alk, Peptonised	P.	,,
	7	P.	Acid, Clot, Peptonised	P.	,,
	8	P.	Acid, Clot, Peptonised	P.	,,
	9	A.	Clot, Alk, Peptonised	P.	,,
	10	A.	Clot, Alk, Peptonised	P.	,,
	11	A.	Clot, Alk, Peptonised	P.	,,
	12	A.	Acid, Clot, Peptonised	P.	,,
	13	A.	Clot, Alk, Peptonised	P.	,,
	14	A.	Clot, Alk, Peptonised	P.	,,
	15	A.	Acid, Clot, Peptonised	P.	,,
	16	A.	Acid, Clot, Peptonised	P.	,,
	17	A.	Acid, Clot, Peptonised	P.	,,
Group 7	1	A.	Acid, Clot, Peptonised	P.	,,
	2	A.	Acid, Clot, Peptonised	P.	,,
	3	A.	Acid, Clot, Peptonised	P.	,,
	4	A.	Acid, Clot, Peptonised	P.	,,
	5	A.	Acid, Clot, Peptonised	P.	,,
	6	A.	Acid, Clot, Peptonised	A.	,,
	7	A.	Acid, Clot, Peptonised	P.	,,
	8	A.	Acid, Clot, Peptonised	P.	,,
	9	A.	Acid, Clot, Peptonised	P.	,,
	10	A.	Acid, Clot, Peptonised	P.	,,
Group 9	1	A.	No reaction	A.	Small oval Bacillus.
	2	A.	Acid, Clot, Peptonised	P.	,, ,,
	3	A.	No reaction	P.	,, ,,
	4	A.	Acid, Clot, Peptonised	P.	Long slender Bacillus.
	5	A.	Acid, Clot, Peptonised	P.	,, ,,
Group 10	1	A.	No reaction	A.	Small Bacillus.
	2	A.	No reaction	A.	Also long curved forms.
Group 13	1	A.	Acid, Clot, Peptonised	A.	Slender Bacillus.
Group 15	1	A.	Acid, Clot, Peptonised	A.	Large Bacillus with spores.
	2	A.	No reaction	A.	Short Bacillus.
Group 16	1	A.	No reaction	A.	Sarcinae.
	2	A.	No reaction	A.	,,
	3	A.	No reaction	A.	,,
	4	A.	No reaction	A.	,,
	5	A.	No reaction	A.	,,
	6	A.	Alkaline	A.	,,
Group 19	1	A.	No reaction	A.	Staphylococcus.
	2	A.	Acid	A.	,,
	3	A.	No reaction	A.	,,
	4	A.	No reaction	A.	,,
	5	A.	No reaction	A.	,,
	6	A.	No reaction	A.	,,
	7	A.	No reaction	A.	,,
	8	A.	No reaction	A.	,,
	9	A.	No reaction	A.	,,
	10	A.	No reaction	A.	,,
	11	A.	No reaction	A.	,,
	12	A.	Acid	A.	,,
	13	A.	No reaction	A.	,,
	14	A.	No reaction	A.	,,
	15	A.	No reaction	A.	,,
	16	A.	No reaction	A.	,,
	17	A.	No reaction	A.	,,
	18	A.	No reaction	A.	,,
	19	A.	No reaction	A.	,,
Group A	1	A.	No reaction	A.	,,
	2	A.	No reaction	A.	,,
	3	A.	No reaction	A.	,,
	4	A.	No reaction	A.	,,
	5	A.	No reaction	A.	Yeast-like.
	6	A.	No reaction	A.	Staphylococcus.
	7	A.	Alkaline	A.	Large Coccus.
Group C	1	A.	Acid	A	Yeast.

P.=Present A.=Absent.

COMPARISON OF THE BACTERIOLOGICAL ANALYSES OF THE RIVER SEVERN WITH THOSE OF OTHER RIVERS.

Investigations on the self-purification of rivers have also been carried on to a considerable extent on the Continent, particularly in Germany, but until quite recently only the total number and the number of liquefying bacteria have been estimated. In recent experiments the number of B. coli has also been recorded by the KI gelatine method. But while it is true that the total number alone is of only secondary importance, yet when an increase is due to sewage, a subsequent diminution probably indicates fairly accurately the amount of purification, and does not exaggerate it. For this reason it is worth while summarising the results obtained by Continental observers. Very different kinds of rivers have been observed varying in size from the Rhine at Cologne to mere brooks around Berlin.

Some official experiments done in 1890 by the Imperial Board of Health in Berlin showed that a small river, 24,710,400 gals. per 24 hours, receiving 1-30th its volume of sewage, left no traces of pollution 70km. below where the town of Rostock took its water supply. In this case very little fæcal matter entered the sewers.

In most instances the results are not so favourable, but the rivers have not been examined so far below the source of pollution. In the case of the Rhine, which has been investigated by several observers, the number of bacteria is permanently increased even 47·5km. below Cologne. The Isar, 33km. below Munich, still contains ten times the number of bacteria found just above Munich. The Limmat, receiving the sewage of Zürich, shows obvious contamination at 10·5km. from the town. In all of these cases the dilution is very considerably more than 1·15, the lowest limits required by Pettenkofer as the result of his experience. The most recent experiments have been made by the Government Committee appointed to investigate rivers from both chemical and biological standpoints. They have taken B. coli as a standard of pollution, and their conclusions will be found to coincide to a considerable extent with our own.

The following table (Table XXX.) shows very clearly the effect of pollution and the distance at which partial purification occurs.

TABLE XXX.

Results of Bacteriological Examination of various Rivers at and below large sources of Pollution.

—	Cologne. River Rhine.		Munich. River Isar.	Zürich. River Limmat.	Grützow. River Warnow.	Dortmund. River Emscher.	Berlin. River Spree.	
Above - - -	4,786	2,000	305	1,667	1,810	—	Above - -	8,951
About ·6 miles below	–	–	9,387	13,336	94,500	1,453,000	Just below -	243,587
„ 2·7 „	–	–	13,503	6,045	—	--	3·5 km. below	343,332
„ 6 „	30,432	9,010	8,764	3,263	12,970	124,000	11 „	170,143
„ 12 „	12,460	3,690	4,796	—	—	220,600	14 „	130,700
„ 15 „	9,595	6,830	3,602	—	—	—	16·5 „	175,048
„ 26 „	7,869	4,720	—	—	850	—	—	9,190

THE SULPHURETTED HYDROGEN (H_2S) FORMING BACTERIA.

These were examined for by the ferro gelatine method on several occasions. In this medium these bacteria produce a rich dark brown colouration owing to the reduction of the iron, and are in consequence easily identified. We found that they were too irregularly distributed to serve as a test of pollution, although undoubtedly they were more numerous in cases of greater pollution. They are abundant where marsh gas is found.

THE SEWAGE FUNGUS.

The "sewage fungus" has been long recognised as an indicator of sewage contamination, but so far as we are aware no scientific description of it has as yet appeared in this country. In Germany, however, Mez and Schorler, with many others, have drawn especial attention to it, and we are now in a position to describe the chief species comprised under the title "sewage fungus." We, ourselves, have had many opportunities of studying it. We have been able to watch it for over one year in the Atcham Brook, which, as previously described, flows into the River Severn, for over two years in the River Alt flowing past the West Derby Sewage Farm; we have found it also at Dewsbury, Leeds, and Birmingham.

The "fungus" is a gelatinous, cottonwool-like, and wavy, white or reddish growth, which is found in shallow water, covering stones, lining drainpipes, or attached to water plants and débris; we have also found it in abundance in a urinal. It is an unmistakable indicator of sewage contamination, and quantities of it are often to be seen in the streams of sewage farms, and in the small brooks and drains highly charged with sewage which are found in the vicinity of houses and villages in the country. In company with the Commissioners we first saw it at Dewsbury in the mouth of the main effluent from the sewage farm. In this case the effluent was very bright, the tufts of the fungus were very long, and of a rusty colour, owing to a deposit of oxide of iron. This form of the fungus we subsequently identified as *Leptomitus lacteus.* Later at Birmingham we encountered great quantities of fungus in the stream receiving the various effluents from the sewage farm. So serious had the growth become at Birmingham that it had been found necessary to remove it by means of screens in order to prevent it from passing into the river where it would have produced a nuisance by setting up "secondary decomposition." That it was capable of doing so was amply demonstrated by that which had already been screened out, and which had been formed into a heap; decomposition had taken place when we saw it, the odour was very offensive, and the red colour of the oxide of iron, so characteristic of the living fungus, had given place to the black colour of the sulphide. In Germany, whilst inspecting one of the large sewage farms at Berlin, we observed "fungus" adhering to the débris in the small effluents, and we were informed that it had been a source of trouble to a bathing establishment situated in the river into which the collected effluents flowed. Subsequent inquiry by the authorities led to the conclusion that in this case no importance could be attached to its presence. There is no doubt, however, that owing to the gelatinous, bulky, and easily decomposable nature of the fungus, and the readiness with which it becomes detached, it may become one of the chief causes of "secondary decomposition" in small rivers and streams which receive sewage.

In the Atcham Brook, where we first found the "fungus" in connection with the Severn experiments, the growth was white, the tufts wavy and very gelatinous, and the brook almost completely choked by it. We could not at first account for its presence, for we were unable to see any source of contamination; bacteriological examination showed that the stream contained

large numbers of the B. coli, viz., 19,000 per cc., and therefore that it must be receiving sewage, and probably close at hand. This surmise proved correct, for we traced the stream to a connection with the sewer of the Atcham workhouse, a building which was hidden from sight from the river, the other feeder of the stream was apparently a pure water spring; the combination of clear running oxygenated water with sewage seems to be necessary for the development of the fungus. We did not observe the fungus passing into the Severn in any large quantity, nor do we think that under any circumstance it could lead to "secondary decomposition" in the river, the volume and velocity and the conditions of growth precluded this. In no part of the river, except in this stream, did we find the fungus, and this is not to be wondered at, considering the very great dilution which we have shown to take place in the sewage of Shrewsbury when it passes into the river. The variety of fungus found in the Atcham Brook proved to be *Sphaerotilus natans.* We have had the opportunity of studying this variety for a very long period in the River Alt, a small stream which receives the effluents from the West Derby Sewage Farm. In this river the growth forms characteristic tufts attached to the stones of the bed of the river. It is readily detached, and is liable to form accumulations and to assist secondary decomposition.

Classed under the heading of "sewage fungus" are certain distinct growths, the most highly organised of which is the Leptomitus, one of the Saprolegniaceæ, and, therefore, comparatively high in the scale of fungi. Next to it comes the Sphaerotilus, which may be placed amongst the more highly developed forms of bacteria. There are also various bacterial zooglea masses, which may assume a branching appearance and simulate a sewage fungus. One of the most interesting observations which we made during our investigations of these most useful fungi, was that in polluted brooks all the appearances of the typical fungus was sometimes caused by extensive growths of a protozoon, the *Carchesium lachmanni.* In the following brief description of the Leptomitus, Sphaerotilus, and Zooglea masses, it will be seen that each variety indicates a different degree of contamination.

*Leptomitus Lacteus (Agardh).**

This oomycete belongs to the family of the *Saprolegniaceae.* It is very soft, almost gelatinous, and may form white, rusty, or black masses. The white appearance is the natural colour of the growing filaments, but very soon this colour is replaced by a deposit on the hyphæ of oxide of iron. The rusty colour of the fungus is very characteristic, and is an indication that the stream in which it is found is well oxygenated If the oxygen is absorbed, as in the interior of masses of the growth, or in stagnant water, sulphide of iron is formed, and the fungus assumes a black colour, and undergoes putrefactive decomposition.

Microscopic examination shows that it consists of long branching filaments, which are constricted at regular intervals; the branches bud off below the constrictions, and each segment has a very characteristic refractile nucleus. Zoospores are formed in the terminal segments.

Sphaerotilus Natans.†

This organism belongs to the Schizomycetes, and may be readily confounded with the preceding. It forms quite as long wavy masses as does Leptomitus. It is, however, usually white and cotton wool-like when seen in the water. It is much more gelatinous than Leptomitus. On stones in shallow streams, or coating the sides of drain pipes, it forms low velvety or feather-like growths. Like leptomitus, it requires oxygen, and grows best in shallow water-courses, and where there is plenty of movement. Its presence indicates much greater pollution than does the former organism, and therefore it is of importance to be able to distinguish the two forms. In two cases where bacterial analyses were made of the water in which both forms of "fungus" were found, that in which leptomitus occurred contained at least less than 100 bacillus coli per c.c., whilst that in which sphaerotilus was found (viz., Atcham Brook) contained over 19,000 bacillus coli per c.c. With the introduction of the bacterial bed method of treatment, this organism has also made its appearance. In one case, where in the method of treatment the bacterial filter is warmed, we found that the sphaerotilus has made its appearance in large quantity, the conditions—circulation, aeration, presence of H_2S and warmth, being most favourable to its devolpment. It is, therefore, an organism which may cause blocking of aerobic contact beds, and from these may find its way into effluents.

Sphaerotilus has been long confounded with Beggiatoa. It is allied to the leptothrix forms. As the microscopic preparations show, it occurs in chains of short bacilli, or as long undivided filaments. It is, therefore, very much more minute than leptomitus. This is readily seen from the photomicrographs, which are equally magnified. The filaments and rods are surrounded with a gelatinous capsule.

A very great interest and importance may attach to this organism, if as Winogradsky has pointed out H_2S is essential to the life of Beggiatoa, and if this organism is the same as the Sphaerotilus. This fact would account for its presence in sewage. But, as pointed out above, it does not grow in crude sewage, although there is plenty of H_2S; this is owing to the absence of the oxygen, which is necessary in order to enable the protoplasm of the cells to take up the sulphur. Its presence, therefore, indicates an oxygenated sewage polluted water, and it is in this class of water in which we have ourselves always found it.

Zooglea Masses.

In crude undiluted sewage, a skin-like growth may form at the sides of the conduit in contact with the air, or at those points where crude sewage passes over a "lip." The growth, which has a coarse velvety appearance, consists of club-shaped zooglea masses of bacilli, and it seems probable that this bacterium, if not identical with Sphaerotilus, is closely allied to it. We found it in the very polluted drains entering the Severn.

From observations at Leeds in connection with the septic tank there appears strong evidence that the zooglea masses tend to form considerable quantities of sulphur from the dissolved sulphuretted hydrogen. Like the Sphaerotilus and Leptomitus they flourish best where the stream of sewage is most active and thinnest. This occurs in the case of the septic tanks at Leeds, where the effluent passes over the lip.

The Sphaerotilus natans can be regarded as peculiar to sewage contaminated water, we are not aware of its growing under any other circumstances. The Leptomitus thrives best in slightly polluted water, and there is no reason to think it may grow to even a slight extent in clean water. The Carchesium lachmanni is a protozoon which we have found in great masses under similar conditions to those of the Sphaerotilus. In our experience in no other conditions does it attain to such a luxuriant growth. Like therefore the sewage fungus it plays no unimportant part in sewage purification. Green algae may also develop to an enormous extent in sewage polluted water, when they do so they may be taken as sewage indicators just in the same way as Sphaerotilus, Leptomitus, and Carchesium. In polluted land drains we have observed great growths of the Flagellate, Euglena viridis, and most recently Dr. MacGowan has sent us a sample, which filled an effluent derived from a coke bed. Similarly Professor Letts has drawn attention to an Ulva in Belfast Loch associated with sewage contamination. Certain products of organic decomposition in the sewage appear to favour the growth of these chlorophyll forms as it does the non-chlorophyll group, and as will be seen in subsequent paragraphs there is evidence that green algae may play a most important and direct share in purifying organically polluted water. When large masses of these green algae perish they give rise, like the sewage fungi, to very objectionable smells.

THE ACTION OF THE PRODUCTS OF DECOMPOSITION DISSOLVED IN THE RIVER.

Diseases in cattle have been attributed to drinking sewage-contaminated river water, but there are no scientific data to show to what substances in the water the diseases were due. Even in the case of anthrax in cattle, the origin of which might be ascribed to drinking con-

* Hildebrand, Jahrb. für wissensch. Bot. Bd. vi.; Pringsheim, Jahrb. für wissensch. Bot. Bd. ii.; Cohn, Jahresber d. Schles. Gesellsch. f. Vaterland, Cultur, 1852.

† Other species have now been described, and these are now engaging our attention, as also methods for their isolation and study in pure cultures.

taminated river water, and where there is a possibility of infection from tannery refuse, and possibly even wool washings finding their way into the sewage, we are not aware that the bacillus has yet been demonstrated in sewage polluted water, although it has been found in a well supplying a flock of sheep.* Nor are we aware that any disease is in fact produced by the abnormal number of bacteria which pollution brings about. These are subjects, however, which require far more investigation than has as yet been given to them, before anything decisive can be said. With regard to the effects of the products of bacterial decomposition there can be little doubt that they act injuriously. We have shown in our oxidation experiments that bacteria when in large quantities absorb a great deal of oxygen, and produce a great deal of carbonic acid, and Spitta has recently calculated that 1 grm. of bacteria require 1·6 c.c. or ·00229 gr. of oxygen per hour. This absorption of oxygen and the evolution of not only CO_2, but of other gases such as H_2S, must act injuriously on fish life. Indeed König and Haselhoff have shown that carp and tench are injuriously affecter by 8 mgr. of H_2S per litre. In the case of the Severn we have shown that there exist large anaerobic deposits of sludge in certain places in the bed of the river passing through Shrewsbury, these give off H_2S, and will, therefore, affect the fish. The fish are also indirectly affected through the plant life in the river. The aquatic plants not only themselves serve for food for certain fishes, but they also harbour the lower forms of animal and vegetable life which help to support fish. We have observed that the green aquatic plants do not grow near the anaerobic decomposing mud, they require oxygen, and it is most probable also that they are as sensitive to dissolved sulphur and other gaseous compounds as are land plants. But this is again a subject which requires much further investigation. We do not wish to overstate the danger to fish life of pollution. Undecomposed sewage, or a non-putrescible effluent is probably innocuous, and it can also readily be understood that a small quantity of sewage entering a river may be rapidly decomposed by bacteria, and contribute largely to the support of the lowest forms of plant and vegetable life, and these in their turn to the higher forms. This does take place, and is comparable to the advantage on land of judicious manuring. We have, however, at Shrewsbury, described excessive pollution, a condition which, unfortunately, exists in many rivers, and which sooner or later produces changes which render higher animal and vegetable life impossible. In addition to bacterial poisons there are numerous instances of the poisoning of fish through mineral poisons discharged into sewage, finding their way into rivers.†

If our knowledge of the harmful effect of the dissolved products of bacteria is very slight, that of other dissolved products, such as toxines, is still less, and we take this opportunity of drawing the attention of the Royal Commissioners to the lack of information concerning the action of these poisonous substances in water which appear to play an important part in the reduction of animal and vegetable life in our polluted rivers. The few experiments which we have made appear to show that the effluent from a Whittaker bed is less toxic than that from a Dibdin bed, and certainly less than septic tank fluid or crude sewage.

CHEMICAL EXAMINATION OF THE RIVER SEVERN.

(Table XXIX.).

The analyses have been carried out by Mr. Frye, who will present his report on this part of the subject; but it might be of use here to make a short comparison between the bacteriological and chemical analyses, because they present some striking contrasts and parallels.

The albuminoid ammonia was high (up to 0·0197) at a time when the pollution as measured by B. coli (less than 30 per c.c.) was low. The total chlorine was highest (2·236) on an occasion when only 9 B. coli per c.c. were present and was low (1·106) when as many as 203 B coli per c.c. were found. Nor is the oxygen absorbed test any better, for on one day we find it at 0·290 with 19 B. coli per c.c., and lower down the river still at 0·290 with 250 B. coli per c.c. But the free ammonia corresponds very closely to the variations in number of B. coli, and on one occasion when the latter was high so far down as Uffington, so also was the free ammonia. The total chemical analysis therefore corresponds roughly to the "total number" of bacteriological analysis, and this we have seen to be more affected by seasonal and meteorological variations than the numbers of B. coli, and we can, therefore, not give it more importance than that attributed to "total numbers"; but the free ammonia apparently corresponds in the chemical to B. coli in the bacteriological analysis, and is, therefore, of considerable interest and importance.

Professor Ramsay's apparatus for the estimation of oxygen has been used three times. Once the river was found to be too muddy to read off the results; on the other two occasions the water was fully oxygenated above and below Shrewsbury; at the Foundry and Cherry Orchard Ferry there were 4 c.c. and 5 c.c. respectively. The pollution as tested in this fashion does not extend very far, although actually we know it to persist to much further down the river. The method has, however, not been given anything like sufficient trial.

THE SELF-PURIFICATION OF THE RIVER SEVERN.

Considerable attention has been paid to this subject upon the Continent by Pettenkofer, Schenk, Uffelmann, Schorler, König, Spitta, and most recently by the German Government. In the reports of the German observers special attention has been given to the classification of the flora and fauna of the polluted rivers, and to the share which they take in purification.

Our own experiments, on the other hand, have for the most part been confined to tracing out as accurately as possible what became of the pathogenic bacteria which found their way into the river. We have, however, also collected, in the time at our disposal, sufficient information upon the wider subject of the purification of rivers to make us entirely agree with the opinion expressed in the last German report that the enquiry is a vast one, and that a great deal of research is still required.

The deleterious action of sewage or of an impure effluent passing into a river arises, firstly, from the presence of pathogenic bacteria, *i.e.*, bacteria harmful to man and animals, and, secondly, from the presence of organic matter, which, undergoing decomposition, not only produces a nuisance and proves dangerous to the health of man, but also has a deleterious effect upon fish and many plants. The self-purification, therefore, of rivers may be considered under two heads—(1) the destruction of pathogenic bacteria, (2) the destruction of organic matter.

1.—DESTRUCTION OF INTESTINAL AND PATHOGENIC BACTERIA IN THE RIVER.

In the preceding pages we brought forward evidence to show that after a certain number of miles, the B. coli, which, for reasons stated elsewhere in this report, we regarded as an organism primarily of the intestine, rapidly diminished in numbers after passing in great quantities into the river with the sewage. It was shown that the B. coli either subsided to the bottom of the river or collected in the mud of the banks, and that there was no evidence of its multiplication, and, moreover, our observations upon the behaviour of the B. coli in the septic tanks and in earth filters corroborated this, and distinctly pointed to its destruction when removed from the alimentary tract. In substances like mud, teeming with putrefactive organisms, the available foodstuff is monopolised by the more hardy bacteria, and the putrefactive products which are formed act detrimentally (so our experiments seem to show) upon the pathogenic forms, but much further research is here again necessary.

The conditions for the multiplication of the B. coli group or of the B. typhosus in the flowing water are also unfavourable. We have no evidence that they multiply, and it has been shown by other observers that river water is unfavourable to their growth. But whilst the condition for the multiplication of these organisms is not met with in a river like the Severn, yet it always must be borne in mind that the B. coli group and the B. typhosus can remain alive for a considerable length of time, both in the mud and in the water.

On looking at the large chart (Chart I.) showing the relative proportion of the B. coli to the common bacteria, it will be seen that both are greatly increased by the inflow of sewage, and that after a certain dis-

*Ann. de l'Institut Pasteur, 1893, p. 286.

†The increasing use of carbolic acid as the common domestic water closet disinfectant, and the large use of disinfectants by municipal authorities, will probably in time produce effects in rivers.

tance has been traversed there is a fall, and the number of organisms is reduced to a figure almost similar to that before the sewage pollution. The explanation of the comparatively rapid disappearance from the river water of the putrefactive bacteria is probably as follows:—

In the case of the B. coli, and presumably also in the case of pathogenic bacteria generally, as we have pointed out, the temperature and environment are unfavourable to multiplication; on the other hand, the multiplication of the coarser bacteria is more dependent upon the food supply. To begin with, they are in an active state of multiplication in the crude sewage as it passes into the river. In this state they are free, and also attached in enormous numbers to the lumps of fat, fæces, and garbage generally. Together with this refuse they pass, as we have shown, to the banks, where the process of putrefaction is continued; quantities are deposited by sedimentation and settle to the bottom of the river, where also putrefaction is continued (as may be readily demonstrated both by bacteriological analyses and by the evolution of gases and putrefactive odours).

Sedimentation and side adhesion play, therefore, a most important part in ridding the flowing water of bacteria. That sedimentation is a powerful agent in reducing the number of bacteria in an effluent or sewage can be artificially demonstrated by adding a small quantity of a precipitant like alum; the organic matter is precipitated, and with it, to a large extent, the bacteria; but, as is well known, organic matter precipitated in this way or by lime or other chemicals is subject to a great amount of subsequent putrefaction, because the bacteria are not killed, but survive to continue their work in the sludge.

In addition to the solid organic matter in suspension in the sewage there is also a considerable amount in solution, which, like laboratory peptone broth, will serve as an admirable nutrient medium for the coarser bacteria. In the case of the Severn, the dilution which the sewage, and therefore which the organic matter in solution, undergoes is very considerable, and the food material is only sufficient for the comparatively small numbers of bacteria, shown in the various appended tables.

The chemical examination shows that after a few miles this food supply in the flowing stream becomes diminished, and at the same time the number of bacteria is greatly decreased. Without food there is no multiplication, and if there is no multiplication the bacteria, like other particles in suspension, undergo gradual sedimentation, and adhere to the sides and bottom of the river. Once incorporated in the mud they will continue to increase or die out according to the presence of suitable food supply and other conditions.

2.—THE DESTRUCTION OF THE ORGANIC MATTER IN THE RIVER.

What become of the impurities, both solid and in solution, carried into the River Severn in the sewage of Shrewsbury, or what would happen to similar impurities present in an improperly purified sewage effluent passing into a river, is a subject of great interest, and one upon which we have been enabled to make many observations. There is evidence to show that the coarser fish, rats, and birds, act as very effective scavengers. The larger animals which dwell in or by the river are the first to reduce much of the offal to excretory products, which in their turn are dealt with by lower forms of animal and vegetable life. By means of the cork experiments, and by numerous other observations we demonstrated that floating bodies tended to go to the banks, where the marginal flora acted as retaining strainers, and that owing to currents considerable accumulations occurred in numerous recesses along the banks. The solid floating matter once brought to the sides of the river becomes incorporated with the mud, and is decomposed by bacteria, just as in the case of manure or sewage on land or in contact beds. Aerobic fermentation takes place in the "wind and water line," viz., that portion of the banks sometimes submerged, sometimes exposed to the air, and reduces the organic matter to nitrates and to other food stuffs, which can be readily taken up by the green plants which flourish luxuriantly along the banks. Sedimentation also occurs, and especially in those parts of the river where the current is sluggish. We compared the action taking place in these sludge accumulations to that in the septic tank; anaerobic and H_2S forming bacteria develop, the mud is black, offensive gases are evolved, and there is no green submerged aquatic plants in their vicinity, because of the injurious products which are formed. Not all the solid matter in suspension collects in these effervescing anaerobic pools which are found in Shrewsbury, for a very large quantity must be carried by the velocity of the stream beyond the town, just as we have proved the B. coli to be carried to the shallow parts of the river. The shallow oxygenated river bed supports a luxuriant growth of the Water Ranunculus and Myriophyllum, the leaves of which are finely divided and adapted in a remarkable manner to strain the water floating through them, as can be seen by the débris and mud, which can be dislodged from them if they are disturbed. When the particles are arrested they are no doubt broken up by bacteria, and by the lower forms of animal life, and are reduced to substances which go to nourish the plants which retain them. The decomposition of the solid matter, whether proteid, fatty, or carbohydrate, is thus accomplished by the aerobic and anaerobic bacteria, which are present in the sewage and sludge, and the grit and insoluble mineral constituents gradually collect on the bed of the river and lead in time to silting. The bacteria are not alone in this destructive process, representatives of the lower forms of green algæ and the protozooa take a share.

In the microscopical examination which we have made of the bed of the Severn we have met representatives of both these groups, but not in such large quantities as has been described by Continental observers. We have found, however, as has already been pointed out in the previous section on "sewage growths," great quantities of motile Protophytes and Carchesium in places where pollution is very great.

The disappearance of soluble organic matter is a subject also of great interest, and about which evidence is accumulating although much further investigation is still needed. The purification is probably both chemical and biological. According to König and Grosse Bohle who have given considerable attention to self-purification sulphur can be oxidised independently of bacteria. Spitta in an extensive examination of the River Spree in the neighbourhood of Berlin, described recently in Volume 38 of the Archiv für Hygiene, carried out investigations showing the value of atmospheric oxygen and sunlight as oxidising agents. In this report, however, we are more immediately concerned with the evidence of the destruction of soluble organic matter through the agency of plant and animal life. The best evidence of the role of biological action is obtained in the small highly polluted drains which enter the Severn. Reference has been repeatdly made to the small brook at Atcham which receives the drainage of the Atcham workhouse before entering the Severn, and which is almost completely filled in places with long wavy gelatinous tufts of Sphaerotilus natans. All observers are agreed that this actively growing organism when in large masses, must take a very great share, if not the greatest share of any species of fungus which we know of, in oxidising the organic matter in solution in sewage. Its action upon sulphuretted hydrogen is also of the highest importance, if it is correct that H_2S is necessary to its growth. Unfortunately, owing to the excedingly bad descriptions of the more highly organised bacteria it is very difficult to determine the species with which those who have studied sulphur formation in bacteria have worked. It seems probable that Sphaerotilus and Beggiatoa have been confused together. The H_2S is largely derived from the decomposition of the numerous organic compounds containing sulphur, which are present in sewage. According to Hoppe-Seyler, however, it may also be produced by the decomposition of cellulose in the following manner. The cellulose is decomposed by bacteria into CH_4; the nascent marsh gas is reduced by calcium sulphate in solution; and H_2S is formed thus:—

$$CH_4 + CaSO_4 = CaCO_3 + H_2S + H_2O.$$

The researches of Winogradsky upon certain bacteria, amongst which further researches may place Sphaerotilus, show that the cells take up the dissolved H_2S, oxidise it, and produce water and free sulphur, and thus render inert a most injurious gas. It will be readily understood how very necessary oxygen is to the growth of these remarkable fungi, they can only accomplish their useful work in sewage when supplied with oxygen. The disadvantage of Sphaerotilus arises from its liability

when formed in large masses, to become detached and perish and to give rise to objectionable odours; therefore if its growth is encouraged care must be taken to prevent it entering streams. Leptomitus lacteus and Carchesium and numerous protozoa no doubt all take a share in getting rid of soluble organic matter. Recently considerable attention has been given to the share which the lower chlorophyll containing forms take in purification. It is not uncommon to find small land drains, especially those on sewage farms, or which receive farmhouse refuse, filled with a green growth for the most part composed of actively motile green cells, and comprising varieties of Euglena and Protococcus. According to Bokorny, König, and Grosse Bohle, these very low green forms can take up their nitrogen and CO_2 better from organic than from inorganic materials alone, and consequently they take a very important share in self-purification. If this is so they will also require not only oxygen as Sphaerotilus does, but also sunlight, and therefore, in contrast to the sewage fungi, they will perform the work best in sunlight. Because of these two, chlorophyll and non-chlorophyll containing groups, the purification of sewage can be carried on throughout the year.

The process of self-purification as briefly sketched above has begun to attract great attention, because in the various biological processes of sewage purification, now largely made use of, a similar purification is brought about by Sphaerotilus, green flagellata, protozoa, and bacteria of all kinds, but it is also evident that much further research is necessary to throw light upon this most interesting and practical subject.

NOTE UPON THE FLORA OF THE RIVER SEVERN AND THE SHARE IT TAKES IN PURIFICATION.

As the relationship of plant life to the purification of our streams is a matter of practical interest, we have made a survey of the plants growing in the river and on the banks, particularly with a view of ascertaining what share they took in cleansing the river.

Early summer, when the river is low, is particularly suited to the study of the flora of the river, and our own observations more particularly apply to the month of June, when the water ranunculus covers extensive reaches of the river with its white flowers.

We have already referred to the "wind and water line," a zone along the banks which is continually kept moist by the slight fluctuations of rising and falling of the stream throughout the day, by the action of the wind in producing waves on the surface of the water, and by capillary attraction. The zone is best seen in summer time, when the height of the river is not subject to extensive variations. In the case of the Severn it is for the most part free from vegetation, and consists of the exposed mud of the bank. The favourable conditions of moisture and food supply, owing to the tendency of organic material to collect to the banks, conduce to bacterial activity, and we have already compared the action which takes place in this zone to that which occurs in a contact bed or in irrigated land. It is also the zone which becomes covered with euglena, oscillatoricæ, closterium, or other protophytes if the water is polluted and the mud offensive. We have found green or blue-green scum on the mud of this zone only in the small polluted streams which enter the Severn, and here and there along the banks of the river itself as it flows through the town, usually after the discharge of a sewer. The polluted mud also harbours much animal life, Nais being especially abundant. It has been recorded that this small worm has reddened the offensive mud of the Thames, and we have ourselves seen masses of it blocking drains; it is also abundant in Dibdin effluents, and swarms may occur on Leptomitus and Sphaerotilus.

The permanently submerged banks support, in the deeper parts, Potamogeton perfoliatus, Potamogeton natans, Zostera, Myriophyllum verticillatum, and Ranunculus aquatica, and in the shallower parts the Sedges, Alisma, water Grasses, and Willows. Close in to the banks the water is sluggish and the growth of pond weeds is favoured; more externally there is often a zone of Myriophyllum; and still more externally, and immediately in contact with the flowing current, there is usually an abundant growth of the water Ranunculus This essentially aquatic flora is more abundant both above and below Shrewsbury than in the town of Shrewsbury, where the conditions of growth are no doubt less favourable. We have pointed out that the banks are often composed of refuse, and in places the mud is septic, or e banks are often washed by concentrated sewage. The available oxygen in the river is therefore much less, and in addition there are no doubt dissolved products of decomposition which are as inimical to plant life in water as certain gases are even in the most minute quantities to terrestial plants. In many parts of the town also the banks are too steep, and do not allow of sufficient foothold for submerged plants. Whilst for the most part plant life is not so abundant in the town, attention will shortly be directed to an exception which occurs at both bridges crossing the river.

The bed of the river from the asylum, two miles above Shrewsbury, to Cressage, 18 miles further down, supports an immense growth of water ranunculus. This weed grows best on a stony bottom, where the current is swift, and where the water is comparatively shallow. In the low state of the river in June, when we made our last survey, we found very little growth in depths of more than four feet, and in winter time this would mean that the plant was submerged to the extent of several feet. The plant forms wavy tufts 6 to 10 feet in length, which are composed of finely branching stems and leaves. The tufts form huge bundles which float in the water, and send to the surface the flowering stems. Everywhere where the river is shallow, and the stream swift, a complete barrier stretches from bank to bank. These barriers occur between the asylum and the waterworks, and below Shrewsbury at Uffington, Atcham, Wroxeter (Roman Ford), and above Cressage. In Shrewsbury itself an extensive growth extends across the river just below Welsh Bridge, and also across the river a short distance above English Bridge, both places where the river becomes very shallow and almost unnavigable, and the current is very swift; above them the river is deep and sluggish. The growth immediately above English Bridge is on a ledge which forms a veritable lip to the very deep pool which we have previously described. The services which these aquatic plants render a polluted river are very great, as after passing through such a barrier, the water is perceptibly brighter and cleaner, and if evidence is wanted of the amount of suspended matter which they filter out, it is only necessary to vigorously disturb a patch in order to give the water the muddy appearance which it has in flood time. The scum which is inseparable from a dirty river is likewise held back, and in certain places accumulates in large quantities. The fringe of Potamogeton and Myriophyllum close to the banks also acts as a most effective filter. The thread-like Conferva grows in immense masses in the meshes of these floating aquatic plants, and increases to a great extent their filtering action.

It is well known that aquatic plants give off great quantities of oxygen in the presence of sunlight, and the quantity produced by the enormous masses of the water ranunculus in the River Severn must be very large. This oxygen formation will most probably materially assist to neutralise the harmful, fermentation which takes place in the more highly polluted parts of the river, both by oxidising organic material and by helping to support those minute forms of animal and vegetable life which destroy organic matter. Microscopical examination of the matter adhering to the aquatic plants reveals the presence of numerous protophytes, protozoa, and bacteria; all of which no doubt take a share in getting rid of the impurities held up by the meshes of the more highly organised plants.

In the bays along the river with their more stagnant water an excellent picture is sometimes afforded of the zones of aquatic plants from bank to mid-stream. There is a bay at Uffington which receives the drainage from a few cottages. Upon the exposed mud, oscillatoriæ and euglena flourish; in the adjacent shallow water there is an abundant growth of conferva; further out the bay is filled with potamogeton perfoliatus and myriophyllum; and most externally, and therefore in contact with the swifter current, we find quantities of the water ranunculus.

It is truly a remarkable feature, and a very fortunate one, that in summer time, when the dilution is much less, and when putrefaction is much more active, the harmful effects of bacterial activity appear to be so soon neutralised. The beneficial effect of the growth of ranunculus on the lip of the deep stagnant pool above English bridge is comparable to the good effects of growth of sphaerotilus in shallow and more highly polluted streams, or of the zooglea masses of bacteria on the lips of the septic tanks at Leeds. But it must not be forgotten that we found the B. coli in larger numbers in low states of the river, so that some particles evidently escape the filtering action of the green weeds.

In winter, when the stream is swollen, and when the volume of water available for the dilution of sewage is very much greater than in summer, the filtering action of the aquatic weeds is very much less. The diluted sewage is carried down the river to a greater distance than in summer, and consequently the possibilities of infection in winter are probably as great as in summer. The banks are to a great extent submerged, with the result that the willows which fringe each side of the river are also partly under water. In this condition their delicate elastic branches take the place of the aquatic plants, and form most efficient strainers of the larger debris which floats in the river. That they have been efficient strainers in the wet season is demonstrated by the large amount of material of all kinds left adhering to them to rot when the river goes down.

CONCLUSIONS.

1. That the B. coli is a most reliable test of pollution.

2. That the B coli is normally absent in 1.c.c. quantities of water taken from the Vyrnwy watershed of the River Severn.

3. That when the B. coli is present in a small stream, contamination from houses can be traced.

4. That small land drains are comparatively free from B. coli.

5. That the small streams running into the Severn often contain considerable quantities of the B. coli due to contamination from proximity to houses.

6. That the sewage of Shrewsbury causes a very great increase in the number of B. coli in the river, and that sixteen miles lower down the effect of pollution can still be detected by the number of B. coli present.

7. That there is no evidence of the multiplication of the B. coli in the river water.

8. That the B. coli is present in considerable numbers in the mud of the Severn in the polluted area, and that this mud may be the means of keeping up and extending pollution, but that there is no evidence of the multiplication of the B. coli in the mud.

9. That there is comparison between total numbers of bacteria and the B. coli, but the relative proportion of the numbers of the latter to the former is small.

10. That differences occur between the number of B. coli in superficial and deep samples, and samples taken near the banks and in stagnant bays, and that therefore cross section samples should always be taken.

11. That sedimentation and side adhesion to the banks of the solids in suspension take place, and that at places in the bed of the river anaerobic fermentation occurs, whilst along the banks, especially in the wind and water line, aerobic bacteria actively help to destroy the organic matter.

12. That certain places in the river are very deep, and that these act as catch pits, that the stream in these places is sluggish, and that sedimentation is favoured.

13. That in the destruction of organic matter, whether solid or in solution, whilst the bacteria take the greatest share, help is also rendered by the protozoa and higher forms of animal life, by the sewage fungi, the chloropyll containing protophytes, and the river plants.

14. That the Sphaerotilus natans is a test of sewage pollution, and that it is a purifier of sewage.

15. That there is no evidence to show that pathogenic bacteria multiply in either the water or mud of the river.

16. That seasonal variations in the number of bacteria occur, but taking the B. coli as the test for pollution that the number of this organism is dependent upon the numbers present in the sewage entering the river, and that when the river is swollen and muddy the number is small owing to increased dilution, and that when the river is low the number is large owing to the lesser degree of dilution which the sewage undergoes when it enters the river.

17. That the effect of dilution of the river upon the sewage of Shrewsbury is most marked. That the average maximum number of B. coli in the river is only 600, per c.c. which is much less than in an average Dibdin effluent, whilst a short distance below pollution the number decreases very considerably.

18. That there is a relationship between chemical and biological analyses.

19. That the River Severn is a good example of a river which it would be difficult to class either as a potable or non-potable stream. It is true that the inhabitants of Shrewsbury consider it as non-potable, for they do not drink the water; but they use it for washing purposes, and consequently there is always a liability for, say, milk to become contaminated by being kept in a can which was washed with the river water. This liability is increased by the fact that the river is practically used as a tidal river, receiving as it does the whole of the untreated sewage of the town. Again, the river in close proximity to the town is used largely for watering cattle. Cattle may therefore contract disease from the water, and such disease may be communicated to human beings.

The river is also used for fishing, and has a recreative and ornamental value.

For these reasons we consider that it is as worthy of protection from pollution as any so-called potable river.

That whilst it would be onerous to expect absolute sterility in any effluent running into such a stream unless some simple method of sterilisation was discovered, yet a certain degree of bacterial purity, as shown by the B. coli test, might be insisted upon in addition to the chemical tests, for it would indicate the extent to which the intestinal bacteria were reduced by the method of sewage treatment employed.

20. That what has been described in this report upon the effects of allowing crude sewage to enter the River Severn is also applicable to biological effluents. Crude sewage is an example of the worst form of pollution, the effluents from biological methods of treatment examples of a lesser degree of contamination, because the solids in suspension in the latter are far less in amount and are in a fine state of division, and the number of the B. coli is smaller.

Shrewsbury with 29,000 inhabitants, and turning crude sewage into the Severn, causes an average pollution of 600 B. coli communis per c.c. (at the point of maximum pollution), and this is felt 16 miles lower down. But if a large town like Leeds were similarly situated, and the sewage were purified by contact beds so as to contain 10,000 B. coli communis per c.c., the pollution would still be about 1,000 B. coli communis per c.c., and if 600 B. coli communis are felt for 16 miles, 1,000 would be felt still further down. Consequently, in spite of the artificial purification, such a river would be in a worse condition than the Severn at Shrewsbury, which is admittedly bad. It follows that the purification thus attained would be insufficient, and that some further treatment would still be necessary.

Therefore a bacteriological examination of sewage effluents is necessary so as to ascertain whether the river can deal effectually with the sewage of its town.

R. BOYCE.

January, 1902.

TABLE I.

Bacteriological Examination of the River Severn above Asylum Outfall.

Date.	Time.	———	Distance.	Number of Bacteria, per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes in c.c.	Thermophilic Bacteria.
			Yards.				
18 Nov. 1899	9 a.m.	Above Asylum outfall	20	—	13	Absent	—
30 Mar. 1900	—	Above Asylum outfall	—	900	2	Absent	5
12 April „	8.45 a.m.	Above Asylum outfall	—	390	1	Absent	2
26 April „	9 a.m.	Above Asylum mixed	—	865	3	Absent	—
17 May „	—	Above Asylum outfall	—	130	Absent	Absent	6
11 July „	—	Above Asylum outfall, surface	—	51,700	Absent	Clot	0
11 July „	—	Above Asylum outfall, deep	—	—	1 (in 3 c.c.)	Absent	0
14 Aug. „	—	Above Asylum outfall, surface	—	1,920	3	Absent	1
14 Aug. „	—	Above Asylum outfall, deep	—	5,850	6	—	7
25 Sept „	—	Above Asylum outfall, surface	—	17,500	Absent	—	—
25 Sept. „	—	Above Asylum outfall, deep	—	44,700	1 (at least)	—	—
18 Oct. „	—	Above Asylum outfall, surface	—	5,700	26	Peptonised	2
18 Oct. „	—	Above Asylum outfall, deep	—	3,750	19	Absent	0
7 Dec. „	—	Above Asylum outfall, surface	—	—	22	Absent	—
7 Dec. „	—	Above Asylum outfall, deep	—	—	22	Absent	—
18 Feb. 1901	—	Above Asylum outfall, surface	—	1,270	1·4	—	—
18 Feb. „	—	Above Asylum outfall, deep	—	2,750	3	—	—
27 Mar. „	—	Above Asylum outfall	—	—	70	—	—

TABLE II.

Bacteriological Examination of the River Severn at the Waterworks.

Date.	Time.	———	Distance.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes in 1 c.c.	Thermophilic Bacteria.
15 Nov. 1899	11.30 a.m.	Midstream, surface	—	15,000	100	Absent	—
15 Nov. „	11.30 a.m.	Midstream, deep	—	26,700	100	Absent	—
15 Nov. „	11.30 a.m.	Left bank, deep	—	62,000	107	Absent	—
18 Nov. „	9 a.m.	Waterworks	—	—	30	Absent	—
11 Jan. 1900	9 a.m.	Waterworks	—	2,400	17	Absent	—
14 Mar. „	—	Waterworks	—	700	72	Absent	8
30 Mar. „	—	Waterworks	—	680	42	Absent	10
30 Mar. „	—	Above Waterworks	—	1,230	87	Present	5
12 April „	8.45 a.m.	Above Waterworks	—	610	16	Absent	3
12 April „	8·45 a.m.	Waterworks	—	430	34	Absent	3
26 April „	9 a.m.	Waterworks, mixed	—	1,890	·23	Present	—
26 April „	9 a.m.	Waterworks, midstream	—	974	31	Present	9
14 Aug. „	—	Waterworks, surface	—	6,700	64	Absent	12
25 Sept. „	—	Waterworks, surface	—	64,500	27	—	—
25 Sept. „	—	Waterworks, deep	—	39,000	Present	—	—
18 Oct. „	—	Waterworks, surface	—	4,300	103	Absent	0
18 Oct. „	—	Waterworks, deep	—	3,250	111	Present (?)	4
7 Dec. „	—	Waterworks, surface	—	—	39	—	—
7 Dec. „	—	Waterworks, deep	—	—	33	—	—
18 Feb. 1901	—	Waterworks, surface	—	2,430	1	—	—
18 Feb. „	—	Waterworks, deep	—	1,330	1·4	—	—

TABLE III.

BACTERIOLOGICAL Examination of RIVER SEVERN at "FERRY I."

Date.	Time	————	Distance.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes in 1 c.c.	Thermophilic Bacteria.
			Miles.				
10 Nov. 1899	2.15 p.m.	Ferry I., shore	—	51,000	Absent in ·01 c.c.	Absent (in ·01 c.c.)	—
15 Nov. "	11.30 a.m.	Ferry I., midstream, surface	0·6	—	137	Present	—
15 Nov. "	11.30 a.m.	Ferry I., deep, midstream	—	20,000	100	Present	—
15 Nov. "	11.30 a.m.	Ferry I., right bank, deep	—	50,000	Absent	Present	—
18 Nov. "	9.50 "	Ferry I., midstream	—	—	250	Present	—
11 Jan. 1900	9 a.m.	Ferry I.	0·6	2,770	50	Present	—
14 Mar. "	—	Ferry I.	—	6,100	60	Present	—
30 Mar. "	—	Ferry I.	—	3,000	130	Absent	9
12 April "	8.45 a.m.	Ferry I.	—	1,400	93	Absent	2
26 April "	9 a.m.	Ferry I., mixed	—	12,750	148	Absent	7
26 April "	9 a.m.	Ferry I., midstream	—	5,100	88	Absent	—
17 May "	—	Ferry I.	—	8,340	100	Pepton	9
14 Aug. "	—	Ferry I., surface	—	34,100	280	Absent	2
14 Aug. "	—	Ferry I., deep	—	27,700	259	Present	1
25 Sept. "	—	Ferry I., surface	—	58,000	800	—	—
25 Sept. "	—	Ferry I., deep	—	48,600	460	—	—
18 Oct. "	—	Ferry I., surface	—	7,900	200	Present (?)	—
18 Oct. "	—	Ferry I., deep	—	6,800	300	Absent	—
7 Dec. "	—	Ferry I., surface	—	—	30	—	—
7 Dec. "	—	Ferry I., deep	—	—	30	—	—
18 Feb. "	—	Ferry I., surface	0·6	6,730	300	Absent (in 0·1 c.c.)	—
18 Feb. "	—	Ferry I., deep	0·6	17,400	60	—	—
27 Mar. "	—	Ferry I., midstream	—	—	40	—	—

TABLE IV.

BACTERIOLOGICAL Examination of the RIVER SEVERN at the ENGLISH BRIDGE.

Date.	Time.	————	Distance.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes in 0·01 c.c.	Thermophilic Bacteria.
			Miles.				
15 Nov. 1899	12.5 p.m.	Midstream, surface	1·6	130,000	143	Present	—
15 Nov. "	12.5 p.m.	Right bank, surface	1·6	43,400	1,067	Present	—
15 Nov. "	12.5 p.m.	Left bank, surface	1·6	21,700	150	Present	—
18 Nov. "	10.5 a.m.	English Bridge	1·6	—	670	Present	—
11 Jan. 1900	9.35 a.m.	English Bridge	1·6	3,110	60	Present	—
14 Mar. "	—	English Bridge	1·6	6,200	491	Present	7
30 Mar. "	—	English Bridge	1·6	6,400	310	Present	12
12 April "	8.45 a.m.	English Bridge	1·6	5,200	573	Absent	4
26 April "	9. a.m.	English Bridge, mixed	1·6	11,040	45	Present	—
26 April "	9. a.m.	English Bridge, midstream	1·6	18,640	65	Present	6
17 May "	—	English Bridge	1·6	9,000	320	Pepton	5
14 Aug. "	—	English Bridge, surface	1·6	34,500	271	Present	5
14 Aug. "	—	English Bridge, deep	1·6	17,300	337	Present	3
25 Sept. "	—	English Bridge, surface	1·6	32,000	312	—	—
25 Sept. "	—	English Bridge, deep	1·6	36,700	540	—	—
18 Oct. "	—	English Bridge, surface	1·6	22,550	700	Absent	0
18 Oct. "	—	English Bridge, deep	1·6	10,500	550	—	0
7 Dec. "	—	English Bridge, surface	1·6	—	30	—	—
7 Dec. "	—	English Bridge, deep	1·6	—	30	—	—
8 Feb. 1901	—	English Bridge, surface	1·6	11,450	30	—	—
8 Feb "	—	English Bridge, deep	1·6	9,200	60	—	—

TABLE V.

BACTERIOLOGICAL Examination of the RIVER SEVERN at "FERRY III."

Date.	Time.	———	Distance.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes in 0·01 c.c.	Thermophilic Bacteria.
			Miles.				
15 Nov. 1899	11.30 a.m.	Midstream, deep	2·5	26,700	Not found in 0·1. c.c.	Present	—
15 Nov. „	11.30 a.m.	Midstream, surface	2·5	31,700	200	Present	—
18 Nov. „	10.15 a.m.	Ferry III.	2·5	—	747	Present (more than 10).	—
11 Jan. 1900	10 a.m.	Ferry III.	2·5	2,200	80	Present	—
30 Mar. „	—	Ferry III.	2·5	3,900	203	Absent (in 0·5 c.c.)	10
12 April „	8.45 a.m.	Ferry III.	2·5	2,770	170	Absent	3
26 April „	9 a.m.	Ferry III., mixed	2·5	16,240	45	Absent	0
26 April „	9 a.m.	Ferry III., midstream	2·5	6,500	Absent in 1 c.c.	Present	8
17 May „	—	Ferry III.	2·5	8,500	247	Present	11
14 Aug. „	—	Ferry III., surface	2·5	29,200	353	Absent	2
14 Aug. „	—	Ferry III., deep	2·5	28,800	278	Absent	4
25 Sept. „	—	Ferry III., surface	..	48,000	905	—	—
25 Sept. „	—	Ferry III., deep	2·5	57,300	1,100	—	—
18 Oct. „	—	Ferry III., surface	2·5	21,900	400	Present (?)	0
18 Oct. „	—	Ferry III., deep	2·5	14,900	250	Absent	0
7 Dec. „	—	Ferry III., surface	2·5	—	30	—	—
7 Dec. „	—	Ferry III., deep	2·5	—	30	—	—
18 Feb. 1901	—	Ferry III., surface	2·5	8,200	30	—	—
18 Feb. „	—	Ferry III., deep	2·5	9,100	140	—	—
27 Mar. „	—	Ferry III., left bank	2·5	—	900	—	—
27 Mar. „	—	Ferry III., right bank	2·5	—	5,200	—	—

TABLE VI.

BACTERIOLOGICAL Examination of the RIVER SEVERN at UFFINGTON FERRY.

Date.	Date.	———	Distance.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes in 1 c.c.	Thermophilic Bacteria.
			Miles.				
15 Nov. 1899	1.10 p.m.	Uffington Ferry, midstream, deep	4·75	33,400	150	Present	—
15 Nov. „	1.10 p.m.	Uffington Ferry, right bank, deep	4·75	—	420	Present	—
15 Nov. „	1.10 p.m.	Uffington Ferry, left bank, deep	4·75	40,000	Doubtful if present at all.	Present	—
11 Jan. 1900	10.50 a.m.	Above Uffington	—	6,670	70	Present (less than 10).	—
11 Jan. „	11 a.m.	Below Uffington	5·	3,050	80	—	—
14 Mar. „	—	Above Uffington	—	2,080	78	Absent	4
30 Mar. „	—	Above Uffington	—	2,350	117	Present	11
26 April „	—	Uffington, mixed	—	9,340	60	Absent	9
26 April „	—	Uffington, midstream	—	4,540	5	Present	—
17 May „	—	Uffington	—	4,800	50	Absent	4
14 Aug. „	—	Uffington, surface	—	9,400	88	Present	5
14 Aug. „	—	Uffington, deep	—	10,400	53	Present	4
25 Sept. „	—	Uffington, surface	—	82,500	236	—	—
25 Sept. „	—	Uffington, deep	—	115,800	277	—	—
18 Oct. „	—	Uffington, surface	—	15,600	490	Present (?)	—
18 Oct. „	—	Uffington, deep	—	6,200	550	Present (?)	—
7 Dec. „	—	Uffington, surface	—	—	30	—	—
7 Dec. „	—	Uffington, deep	—	—	70	—	—
11 Jan. 1901	10.50 a.m.	Below Uffington	—	3,050	80	Absent (in 0·01 c.c.)	—
18 Feb. „	—	Uffington, surface	—	3,300	30	—	—
18 Feb. „	—	Uffington, deep	—	2,600	70	—	—
12 April „	8 45 a.m.	Uffington	—	3,400	115	Absent	—

TABLE VII.

Bacteriological Examination of River Severn at Atcham Bridge.

Date.	Time.	———	Distance.	Number of Bacteria, per c. c.	B. Coli Communis per c.c.	B. Enteritidis sporogenes in 1 c.c.	Thermophilic Bacteria.
			Miles.				
15 Nov. 1899	12.40 p.m.	Atcham Bridge, midstream, surface -	9	—	50	Absent	—
15 Nov. "	" "	Atcham Bridge, right bank, surface -	9	28,000	10	Absent	—
15 Nov. "	" "	Atcham Bridge, left bank, surface -	9	28,400	100	Absent	—
18 Nov. "	10.45 a.m.	Atcham, midstream - - -	9	—	53	Present (less than 10).	—
18 Nov. "	" "	Atcham, right bank - - - -	9	—	40	Absent	—
11 Jan. 1900 -	12.15 p.m.	Above Atcham - - - - -	8·5	1,900	20	Present (less than 10).	—
11 Jan. "	12.25 p.m.	Below Atcham - - - - -	9·2	2,100	57	Present (less than 10).	—
14 Mar. "	—	Atcham - - - - - - -	9	1,410	13	Absent	5
30 Mar. "	—	Atcham - - - - - - -	9	1,650	11	Present	7
30 Mar. "	—	Below Atcham - - - - -	9	—	—	—	—
12 Apr. "	—	Atcham - - - - - - -	9	2,470	29	Absent	22
26 Apr. "	9 a.m.	Atcham, mixed - - - - -	9	3,820	3	Present	—
26 Apr. "	"	Atcham, midstream - - - -	9	2,750	9	Absent	2
26 Apr. "	"	Atcham - - - - - - -	9	2,900	16	Peptone	5
17 May "	—						
14 Aug. "	—	Atcham, surface - - - - -	9	10,900	37	Absent	3
14 Aug. "	—	Atcham, deep - - - - -	9	7,700	64	Absent	5
25 Sept. "	—	Atcham, surface - - - - -	9	36,100	124	—	—
25 Sept. "	—	Atcham, deep - - - - -	9	35,100	69	—	—
18 Oct. "	—	Atcham, surface - - - - -	9	13,500	83	Absent	—
18 Oct. "	—	Atcham, deep - - - - -	9	13,600	117	Present (?)	1
7 Dec. "	—	Atcham, surface - - - - -	9	—	32	—	—
7 Dec. "	—	Atcham, deep - - - - -	9	—	26	—	—
11 Jan. 1901 -	12.25 p.m.	Below Atcham - - - - -	9·2	2,100	57	Absent (in 0·1 c.c.)	—
18 Feb. "	—	Atcham, surface - - - - -	9	8,400	11	—	—
18 Feb. "	—	Atcham, deep - - - - -	9	59,000	10	—	—

TABLE VIII.

BACTERIOLOGICAL Examination of the RIVER SEVERN at CRESSAGE

Date.	Time.	———	Distance.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes in 1 c.c.	Thermophilic Bacteria.
			Miles.				
18 Nov. 1899	11.30 a.m.	Cressage, midstream	—	—	73	Present (less than 10).	—
18 Nov. ,,	,, ,,	Cressage, right bank	—	—	70	Present (less than 10).	—
1 Jan. 1900	2.40 p.m.	Cressage	16	3,940	40	Absent	—
1 Feb. ,,	11.45 a.m.	Cressage Bridge, banks	—	1,185	25	Absent (in 0·1 c.c.)	—
1 Feb. ,,	,, ,,	Cressage Bridge, middle		1,070	73	Absent (in 0·1 c.c.)	—
1 Feb. ,,	12.45 p.m.	Cressage, banks	—	1,935	17	Absent (in 0·1 c.c.)	—
1 Feb. ,,	,, ,,	Cressage Bridge, middle	—	1,570	29	Absent (in 0·1 c.c.)	—
1 Feb. ,,	1.45 p.m.	Cressage Bridge, banks	—	1,125	44	—	—
1 Feb. ,,	,, ,,	Cressage, middle	—	2,040	25	—	-
1 Feb. ,,	2.45 p.m.	Cressage, banks	—	1,405	35	—	—
1 Feb. ,,	,, ,,	Cressage, middle	—	1,540	42	—	—
1 Feb. ,,	3.25 p.m.	Cressage, banks	—	1,910	22	Absent (in 0·2 c.c.)	—
1 Feb. ,,	,, ,,	Cressage, middle	—	3,870	33	Absent (in 0·2 c.c.)	—
1 Feb. ,,	4.15 p.m.	Cressage, banks	—	1,740	27	—	—
1 Feb. ,,	,, ,,	Cressage, middle	—	—	—	—	—
14 Mar. ,,	—	Cressage	—	2,490	46	Absent	Overgrown.
30 Mar. ,,	—	Cressage	—	—	15	Absent	10
12 Apr. ,,	3 40 p.m.	Cressage	—	3,100	48	Absent	4
26 Apr. ,,	9 a.m.	Cressage, mixed	—	5,100	3	Present	—
26 Apr. ,,	,,	Cressage, midstream	—	9,600	23	Present	14
17 May ,,	—	Cressage	—	1,010	9	Absent	6
31 May ,,	—	Cressage (above Bridge)	—	1,866	15	Acid	5
14 Aug. ,,	—	Cressage, deep	—	3,350	48	Present	13
14 Aug. ,,	—	Cressage, surface	—	9,850	75	Present	10
25 Sept. ,,	—	Cressage, surface	—	22,200	21	—	
25 Sept. ,,	—	Cressage, deep	—	12,600	1 (in 3 c.c.)	—	—
18 Oct. ,,	—	Cressage, surface	—	16,400	—	Present (?)	5
18 Oct. ,,	—	Cressage, deep	—	10,300	—	Present (?)	4
7 Dec. ,,	—	Cressage, surface	—	—	100	—	—
7 Dec. ,,	—	Cressage, deep	—	—	30	—	—
18 Feb. 1901	—	Cressage, surface	—	3,900	10	—	—
18 Feb. ,,	—	Cressage, deep	—	3,400	30	—	—

TABLE IX.

BACTERIOLOGICAL Examination of RIVER SEVERN at SHREWSBURY and Below.

Date.	Time.	Place.	Distance.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes.
			Miles.			
10 Nov. 1899	2.15 p.m.	Waterworks	—	280,000	Absent in ·01 c.c.	Present in 1 c.c.
		Welsh Bridge	0·4	420,000	,, ,,	Absent in 0·01 c.c.
		Ferry I, midstream	0·6	434,000	,, ,,	,, ,,
		Ferry I, shore	—	51,000	,, ,,	,, ,,
		Ferry II, midstream	0·8	53,000	,, ,,	,, ,,
		English Bridge, midstream	1·6	270,000	,, ,,	,, ,,
		English Bridge, shore	—	365,000	,, ,,	,, ,,
		Ferry III, midstream	2·5	213,000	,, ,,	,, ,,
		Ferry III, shore bank	—	30,000	,, ,,	,, ,,
		Uffington Ferry	4·75	51,700	,, ,,	,, ,,
	2.20 p.m.	Atcham Bridge	9	95,000	100 per c.c.	,, ,,

Height of river at Cherry Orchard Ferry, 10 feet 3 inches. In flood.

TABLE X.

Bacteriological Examination of River Severn at Shrewsbury and Below.

Date.	Time.	Place.	Distance.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes, in 1 c.c
			Miles.			
15 Nov. 1899	11.30 a.m.	Waterworks	—			
		Midstream, surface	—	15,000	100	Absent.
		Midstream, deep	—	26,700	† 100	Absent.
		Left bank, deep	—	62,000	107	Absent.
	11.35 a.m.	Ferry I.	0·6			
		Midstream, surface	—	—	137	*Present.
		Midstream, deep	—	20,000	100	Present.
		Right bank, deep	—	50,000	Absent	*Present.
	12.5 p.m.	English Bridge	1·6			
		Midstream, surface	—	130,000	143	*Present.
		Right bank, surface	—	43,400	1,067	Present.
		Left bank, surface	—	21,700	150	*Present.
	12.15 p.m.	Ferry III.	2·5			
		Midstream, deep	—	26,700	Not found in $\frac{1}{100}$ c.c.	*Present.
		Midstream, surface	—	31,700	200	*Present.
	1.10 p.m.	Uffigton Ferry	4·75			
		Midstream, deep	—	33,400	150	*Present.
		Right bank, deep	—	—	420	*Present.
		Left bank, deep	—	40,000	Doubtful if present at all.	*Present.
	12.40 p.m.	Atcham Bridge	9			
		Midstream, surface	—	—	50	Absent.
		Right bank, surface	—	28,000	10	Absent.
		Left bank, surface	—	28,400	100	Absent.

The river was no longer muddy. Height at Cherry Orchard Ferry, 5 ft. 5 in.

* Less than 10 per c.c. † Probably under-estimated.

TABLE XI.

Bacteriological Examination of River Severn at Shrewsbury and Below.

Date.	Time.	Place.	Distance.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes in 1 c.c.
18 Nov. 1899	9 a.m.	Above Asylum outfall 20 yds.	—	—	13	Absent.
	9.30 a.m.	Below Asylum outfall	—	—	22,630	Present (more than 10).
	—	Waterworks	—	—	30	Absent.
	9.50 a.m.	Ferry I., midstream	—	—	250	Present (less than 10).
	10·5 a.m.	English Bridge	—	—	670	Present (more than 10).
	10·15 a.m.	Ferry III.	—	—	747	Present (more than 10).
	10·45 a.m.	Atcham, midstream	—	—	53	Present (less than 10).
	—	Atcham, right bank	—	—	40	Absent.
	11.10 a.m.	River Meole	—	—	Doubtful if present in $\frac{1}{10}$ c.c.	Absent.
	11.30 a.m.	Cressage, midstream	—	—	73	Present (less than 10).
	—	Cressage, right bank	—	—	70	Present (less than 10).
	12 noon	Cressage, brook	—	—	17	Absent.
	12.15 p.m.	Conduit (drinking), Shrewsbury	—	—	2	Absent.
	1.45 p.m.	Tap water, Shrewsbury	—	—	(1) 20 (2) 14	Absent.

Height of river at Cherry Orchard Ferry, 3 ft. 10 in.

TABLE XII.

Bacteriological Examination of River Severn at Shrewsbury and Below.

Date.	Time.	Place.	Distance.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes in 1 c.c.
			Miles.			
11 Jan. 1900 -	9 a.m.	Waterworks - - - - - - -	0·	2,400	17	Absent.
	9.10 a.m.	Ferry I. - - - - - - -	0·6	2,770	50	*Present.
	9.35 a.m.	English Bridge - - - - - -	1·6	3,110	60	*Present.
	10 a.m.	Ferry III. - - - - - - -	2·5	2,200	80	*Present.
	10.50 a.m.	Above Uffington - - - - - -	4·5	6,670	70	*Present.
	11 a.m.	Below Uffington - - - - - -	5·	3,050	80	*Present.
	11.35 a.m.	Above Preston Ferry - - - -	—	3,540	90	*Present.
	12.15 p.m.	Above Atcham - - - - - -	8·5	1,900	20	*Present.
	12.25 p.m.	Below Atcham - - - - - -	9·2	2,100	57	*Present.
	1.5 p.m.	Inflow, River Tern - - - - -	10·5	4,910	60	*Present.
	1.25 p.m.	Below Wroxeter - - - - - -	11·5	3,300	20	*Present.
	1.55 p.m.	Inflow, Cound Brook - - - - -	12·8	—	14	*Present.
	2.5 p.m.	Above Cound - - - - - - -	13·4	5,400	14	Absent.
	2.10 p.m.	Below Cound - - - - - - -	13·6	4,750	50	Absent.
	2.40 p.m.	Cressage - - - - - - - -	16·	3,940	40	Absent.

The river was in flood and turbid. Samples were taken from a boat drifting with the stream. Height at Cherry Orchard Ferry 9 ft. 5 in.

* Less than 10 per c.c.

TABLE XIII.

Bacteriological Examination of River Severn at Cressage Bridge.

Date.	Time.	Right Bank.		Middle.		Left Bank.		Average.		B. Enteritidis Sporogenes.
		B. Coli Communis per c.c.	Numbers.	B. Coli Comminis per c.c.	Numbers.	B. Coli Communis per c.c.	Numbers.	B. Coli Communis per c.c.	Numbers.	
1 Feb. 1900	11.45 a.m.	24	1,000	70	1,070	25	1,370	42	1,146	Absent in 0·1 c.c.
	12.45 p.m.	17	2,600	29	1,570	16	1,270	21	1,813	Absent in 0·1 c.c.
	1.45 p.m.	45	1,150	45	2,040	43	1,100	44	1,430	Left bank: atypical.
	2.45 p.m.	20	1,140	42	1,540	50	1,670	37	1,450	Left bank: present in 1 c.c.
	3.45 p.m.	13	1,750	33	3,870	80	2,070	25	2,563	Absent in 0·2 c.c.
	4.15 p.m.	27	1,740	—	—	—	—	—	—	—
	Average -	24	1,528	45	2,018	33	1,496	34	1 680	

River swollen and turbid. Height at Cherry Orchard Ferry 5 ft. 3 in

TABLE XIV.

Bacteriological Examination of River Severn at Shrewsbury and Below

Date.	Place.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes per c.	Thermophiles per c.c.
14 Mar. 1900	Waterworks	700	72	Absent	8
	Drain entry	3,470	127	Present	3
	Sewer entry	3,250	176	Present	5
	Ferry I.	6,100	60 (probably too low.)	Present	3
	English Bridge	6,200	491	Present	7
	Ferry II.	5,900	317	Present	4
	Just above municipal boundary	4,700	195	Present	2
	Ditherington sewer	9,640	97 (perhaps too high.)	Present	31
	Land drain, left bank, above Penley Rough	3,200	Absent	Absent	50
	Land drain, right bank, opposite Penley Rough	2,600	Absent	Absent	10
	Above Uffington	2,086	78	Absent	4
	Land drain above Uffington, left bank	754	Absent	Absent	Overgrown.
	Mill Brook at Uffington, left bank	1,390	16	Absent	14
	Land drain, right bank, Ford	1,090	Absent	Absent	—
	Land drain	1,060	Absent	Absent	34
	Land drain, right bank, railway bridge	2,080	Absent	Absent	2
	Land drain, municipal boundary just below Preston	1,570	25	Present	7
	Atcham	1,410	13	Absent	5
	Land drain below Atcham	1,260	Absent	Absent	11
	River Tern	1,230	2	Absent	16
	Land drain, Bell Brook	329	Absent	Absent	16
	Land drain below Wroxeter	350	19	Absent	16
	Cound Brook	880	1	Absent	5
	Above Cound	2,310	22	Absent	3
	Cressage	2,490	46	Absent	5

The river, clean at the Waterworks soon became dirty in the town, particularly below the railway bridge, and remained so till near Uffington. Except single houses, no evidence of pollution was seen. In the town itself no fæcal matter was observed in the river, but near Pineapple Farm and below, at about 10·37 and 10·55 respectively, the boat passed through zones containing considerable fæcal matter. Height at Cherry Orchard Ferry, 3 ft. 3 in.

TABLE XV.

Bacteriological Examination of River Severn at Shrewsbury and Below.

Date.	Place.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes per c.c.	Thermophiles per c.c.
30 Mar. 1900	Above Asylum	900	2	Absent	5
	Fifty yards below Asylum right bank	3,700	677	Present	3
	Above Waterworks	1,230	87	Present	5
	Bed of River at Waterworks	- - -	167	Absent	0 over.
	Waterworks	680	42	Absent	10 grown
	Bed above Welsh Bridge	- - -	1,450 per grm.	Present (in 0·5 c.c.)	ca. 100
	Ferry I.	3,000	130	Absent	9
	English Bridge	6,400	310	Present (in 0·1 c.c.)	12
	Ferry III.	3,900	203	Absent (in 0·5 c.c.)	10
	Municipal Boundary	4,700	250	Present	Cloud.
	Above Uffington	2,350	117	Present	11
		320	4	Absent	0
	Land drain, left bank	110	Absent	Absent	0
	Land drain, Burtons	965	Absent	Absent	12
	Atcham	1,650	11	Present	7
	Below Atcham	—	—	—	—
	Sewer of Atcham Workhouse	255,500	19,440	Present	40
	Wroxeter	1,260	6	Present	13
	Land drain, Coton's	110	Absent	Absent	0
	Land drain, right bank, Lower Cound Farm	610	Absent	Absent	5
	Above Cound	3,860	9	Absent	4
	Below Cound	2,720	15	Absent	6
	Cressage	- - -	15	Absent	10

The river a little higher than before. It looked somewhat dirtier everywhere, and although fairly clear above the Asylum outfall, below this solid fæcal matter and paper could be recognised right down to the intake of the Municipal Waterworks. Throughout the town fæcal matter, &c., could be observed, but the river is particularly dirty just beyond the Footbridge. Zones of sewage were met with as far as Monksmoor, and paper was seen even some distance below Atcham. Height at Cherry Orchard Ferry, 3ft. 5in.

TABLE XVI.

BACTERIOLOGICAL Examination of RIVER SEVERN at SHREWSBURY and Below.

Date.	Time.	Place.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes per c.c.	Thermophiles per c.c.
12 April 1900	8.45 a.m.	WATER				
		Above Asylum outfall	390	1	Absent	2
		200 yards below, right bank	2,500	1,130	Absent	3
		200 yards below, left bank	365	Absent in 1 c.c.	Absent	Spreading.
		400 yards below, left bank (Stagnant Bay).	1,400	100	Absent	—
		Above Waterworks	610	16	Absent	3
		At Waterworks	430	34	Absent	3
		Ferry I.	1,400	93	Absent	2
		English Bridge	5,200	573	Absent	4
		Bay below Railway Bridge	9,000	173	Absent	13
		Ferry III.	2,770	170	Absent	3
		Ditch at Fever Hospital	1,950	6	—	1
		Uffington	3,400	115	Absent	3
		? House drain, above Railway Bridge II.	170,000	433	Absent	4
		Land drain just above Railway Bridge II.	1,160	73	Absent	—
		Atcham	2,470	29	Absent	22
		Drain in Atcham	14,250	160	Absent	3
		Atcham Workhouse sewer	320,000	11,080	Present (in 0·1 c.c.)	120
		Above Cound	3,550	44 ?	Present	1
		Drain, Cound Inn	3,570	Doubtful, probably absent.	Absent	—
		Below Cound Inn	3,150	15	Absent	1
	3.40 p.m.	Cressage	3,100	48	Absent	4

The river was higher than on March 30th, and the current considerably more rapid. As a whole more muddy, but not so obviously sewage polluted. No fæcal matter seen below the town, nor very far below Asylum sewer. Below Atcham a sewer containing a luxuriant growth of sphaerotilus was discovered.

TABLE XVII.

BACTERIOLOGICAL Examination of RIVER SEVERN at SHREWSBURY and Below.

Date.	Time.	Place.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes per c.c.	Thermophiles per c.c.
26 April 1900	9 a.m.	Above Asylum, mixed	865	3	Absent	—
		100 yards below Asylum, mixed	2,400	65	Absent	1
		Waterworks, mixed	1,890	23	Present	—
		Waterworks, midstream	974	31	Present	9
		Ferry I., mixed	12,570	148	Absent	7
		Ferry I., midstream	5,100	88	Absent	—
		English Bridge, mixed	11,040	45	Present	—
		English Bridge, midstream	18,640	65	Present	6
		Stagnant Bay below Railway Bridge	13,800	53	Present	6
		Ferry III., mixed	16,240	45	Absent	—
		Ferry III., midstream	6,500	Absent in 1c.c.	Present	8
		Stagnant Bay below "Canal Bridge"	9,920	45	Absent	2
		Uffington, mixed	9,340	60	Absent	9
		Uffington, midstream	4,540	5	Present	—
		Atcham, mixed	3,820	3	Present	—
		Atcham, midstream	2,750	9	Absent	2
		Atcham Workhouse sewer	270,000	100	Present	23
		400 yards below sewer	3,400	Doubtful, probably absent.	Present	8
		Above Cound, mixed	6,470	24	Atypical	2
		Above Cound, midstream	2,200	5	Absent	—
		Below Cound, midstream	6,100	15	Present	4
		Cressage, mixed	5,100	3	Present	
		Cressage, midstream	9,600	23	Present	14

River about normal height. At 10.30 p.m. on the 25th inst. about two gross red corks thrown over Welsh Bridge. On the following day the last cork was seen in the stream just below Preston Ferry. Height at Cherry Orchard Ferry 3 ft. 0 in.

TABLE XVIII.

BACTERIOLOGICAL EXAMINATION of RIVER SEVERN at SHREWSBURY and Below.

Date.	Place.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes c.c.	Thermophiles per c.c.
17 May 1900.					
	Above Asylum outfall	130	Absent	Absent	6
	Opposite Graserhill	(Liquefied)	23	Absent	3
	Ferry I.	8,340	100	Pepton	9
	English Bridge	9,000	320	Pepton	5
	Ferry III.	8,500	247	Present	11
	Uffington	4,800	50	Absent	4
	Atcham	2,900	16	Pepton	5
	?Sewer (Below Workhouse sewer)	8,300	32	(.01 c.c.) atypical	7
	Cound	1,360	15	Present	8
	Cressage	1,010	9	Absent	6
	Above Eye Farm	4,500	11	—	2
	Sheinton Brook	34	3	Absent	18
	Mary's Dingle Brook	1,500	Absent	Absent	—
	"Abbey" Brook	840	9	Pepton	25
	Marnwood Lodge	170	8	Absent	7
	Ironbridge	(Liquefied)	7	Absent	1

Height of river at Cherry Orchard Ferry, 3 ft. 1 in.

TABLE XIX.

BACTERIOLOGICAL EXAMINATION of RIVER SEVERN at SHREWSBURY and Below.

Date.	Time.	PLACE.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes per c.c.	Thermophiles per c.c.
31 May 1900.	9 a.m.					
		Cressage Brook	2,600	43	Pepton	19
		Cressage (above Bridge	1,866	15	Acid	5
		Land drain	303	44	Absent	2
		River (at same spot)	741	7	Acid	8
		Brook (? Belswary, Pyne Hall)	823	26	Present	1
		Brook below Eye Farm	10,566	10	Acid	8
		Sheinton Brook	763	10	Acid	11
		Mary's Dingle Brook	915 (two plates only)	97	Clot	3
			2,366	12	Acid	4
		Holy Trinity Brook	4,320 (one plate only)	41	Acid	26
		"Abbey" Brook	1,502	9?	Present	13
		River at "Abbey" Bridge	2,243	16	Absent	1
		Buildwas Junction Brook	5,373	437	Pepton	23
		Marnwood House Brook	2,800 (one plate only)	258	Absent	1
		Strethill Farm drain	Liquefied.	?	Pepton	2
		Cesspool Overflow (A.E. Bridge)	more than 120,300	Apparently absent	.01 c.c.	45
		River (Opposite Severn House)	120,300	8	Pepton	5
		Sewer (just below this point)	120,300	3,800	Present	.06 c.c.
		Mill sluice	14,830	241	Absent	6
		Ironbridge	Liquefied.	Doubtful.	Present	1

Large sackful of white corks thrown over Cressage Bridge at 10.30 p.m. May 30th. Last cork seen at Ironbridge (the end of journey).
Height at Cherry Orchard Ferry 2ft. 2in.

TABLE XX.

Bacteriological Examination of River Severn at Shrewsbury and Below.

Date	Place.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes.	Thermophiles per c.c.
11 July 1900	Above Asylum, surface	51,700	Absent	Clot	—
	Above Asylum, deep	—	1 in 3 c.c.	—	—
	Just above Waterworks	47,000	1 in 3 c.c.	—	—
	Waterworks, surface	51,470	*469	Clot	—
	Waterworks, deep	99,870	995	Clot	—
	Ferry I., surface	1,513,340	1,100	Present	—
	Ferry II., deep	1,540,000	430	Clot	—
	Bay below Ferry I.	2,520,000	810	Peptonised	—
	English Bridge, deep	800,000	760	Absent	
	English Bridge, surface	1,232,000	370	Present	—
	Ferry III., deep	941,000	573	Clot	—
	Ferry III., surface	—	—	Absent	—
	Uffington, surface	200,000	332	Clot	—
	Uffington, deep	193,400	269	—	—
	Drinking Water, Shrewsbury	100	Absent	Absent	—

* Numbers probably much too high.

The river was rather low. Mr. Kershaw's measurement gave a total of 112,008,000 gallons per 24 hours. Many of the sewer openings were only just under water, and the turbid stream issuing from them could be traced some distance. Many yellow corks (thrown in 17th May) were seen at various points along the whole course. Height at Cherry Orchard Ferry, 1 ft. 8 in.

TABLE XXI.

Bacteriological Examination of River Severn at Shrewsbury and Below.

Date.	Place.	Number of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes per c.c.	Thermophiles per c.c.
14 Aug. 1900	Above Asylum, surface	1,920	3	Absent	1
	Above Asylum, deep	5,850	6	—	7
	Waterworks, surface	6,700	64	Absent	12
	Ferry I., surface	34,100	280	Absent	2
	Ferry I., deep	27,700	259	Present	1
	English Bridge, surface	34,500	271	Present	5
	English Bridge, deep	17,300	337	Present	3
	Ferry III., surface	29,200	353	Absent	2
	Ferry III., deep	28,800	278	Absent	4
	Uffington, surface	9,400	88	Present	5
	Uffington, deep	10,400	53	Present	4
	Atcham, surface	10,900	37	Absent	3
	Atcham, deep	7,700	64	Absent	5
	Cound, surface	10,500	59	Absent	2
	Cound, deep	8,000	59	Absent	14
	Cressage, surface	9,850	75	Present	10
	Cressage, deep	3,350	48	Present	13
	Sheinton Brook	8,100	80	Present	9
	Mary's Dingle Brook	3,250	8	Absent	30
	Above Ironbridge, surface	10,200	91	Present	3
	Above Ironbridge, deep	5,300	91	Present	6
	Ironbridge, surface	5,400	28	Present	12
	Ironbridge, deep	6,200	107	Present	10

River had been in flood a few days previously and the water was still muddy. Cross-section samples. Height at Cherry Orchard Ferry, 3 ft. 5 in.

TABLE XXII.

BACTERIOLOGICAL Examination of RIVER SEVERN at SHREWSBURY and Below.

Date.	Place.	Number of Bacteria per c.c.	B. Coli Communis per c.c.
25 September 1900.	Above Asylum, surface	17,500	Absent.
	Above Asylum, deep	44,700	1 (at least.)
	Below Asylum, surface	40,400	620
	Below Asylum, deep	19,200	166
	Waterworks, surface	64,500	27
	Waterworks, deep	39,000	Present.
	Ferry I., surface	58,000	800
	Ferry I., deep	48,600	460
	English Bridge, surface	32,000	312
	English Bridge, deep	36,700	540
	Ferry III., surface	48,000	905
	Ferry III., deep	57,600	1,000
	Uffington, surface	82,500	236
	Uffington, deep	115,800	277
	Atcham, surface	36,700	124
	Atcham, deep	36,100	69
	Cound, deep	13,900	1
	Cressage, surface	22,200	21
	Cressage, deep	12,600	1 in 3 c.c.

River at lowest level yet examined. Height at Cherry Orchard Ferry, 1 ft. 5 ins.

TABLE XXIII.

BACTERIOLOGICAL Examination of RIVER SEVERN at Shrewsbury and Below.

Date.	Place.	No. of Bacteria per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes per c.c.	Thermophiles per c.c.
8 Oct. 1900	Above Asylum, surface	5,700	26	Present (?)	2
	Above Asylum, deep	3,750	19	Absent	—
	Below Asylum, surface	15,500	190	Present (?)	—
	Below Asylum, deep	9,400	130	Present (?)	1
	Waterworks, surface	4,300	103	Absent	—
	Waterworks, deep	3,250	111	Present (?)	4
	Ferry I., surface	7,900	200	Present (?)	—
	Ferry I., deep	6,800	300	Absent	—
	English Bridge, surface	22,556	700	Absent	—
	English Bridge, deep	10,500	550	—	—
	Ferry III., surface	21,900	400	Present (?)	—
	Ferry III., deep	14,900	250	Absent	—
	Uffington, surface	15 600	490	Present (?)	1
	Uffington, deep	6,200	550	Present	—
	Atcham, surface	13,500	83	Absent	—
	Atcham, deep	13,600	117	Present (?)	1
	Atcham sewer	210,000	—	Present (?)	3
	Cound, surface	31,900	—	Absent	2
	Cound, deep	10,600	—	Present (?)	—
	Cressage, surface	16,400	—	Present (?)	5
	Cressage, deep	10,300	—	Present (?	4

River going down after flood ; consequently everywhere rather muddy. Cross-sections, superficial and deep, were taken simultaneously. Height
t Cherry Orchard Ferry, four feet.
Bile Salt Agar used. Medium too alkaline for accuracy.
All were atypical where (?) is appended.

TABLE XXIV.

Bacteriological Examination of River Severn at Shrewsbury and Below.

Date.	Place.	B. Coli Communis per c.c.
7 December 1900 -	Above Asylum, surface - - - -	22
	Above Asylum, deep - - - -	22
	Below Asylum, surface - - - -	28
	Below Asylum, deep - - - -	49
	Waterworks, surface - - - -	39
	Waterworks, deep - - - - -	33
	Ferry I., surface - - - - -	30
	Ferry I., deep - - - - - -	30
	English Bridge, surface - - - -	30
	English Bridge, deep - - - -	30
	Ferry III., surface - - - - -	30
	Ferry III., deep - - - - -	30
	Uffington, surface - - - - -	30
	Uffington, deep - - - - -	70
	Atcham, surface - - - - -	32
	Atcham, deep - - - - - -	26
	Cound, surface - - - - -	30
	Cound, deep - - - - - -	30
	Cressage, surface - - - - -	100
	Cressage, deep - - - - -	30
	Atcham Sewer - - - - -	30

The river was in flood; higher than on 11th January 1900; most of the gelatine plates unfortunately liquefied, so that no reliable counts could b made. Height at Cherry Orchard Ferry, 10ft. 10ins.
No sphaerotilus seen in Atcham sewer.
5th January 1901. Volume 1,054,944,000 gallons per 24 hours.

TABLE XXV.

Bacteriological Analysis of Streams entering River Severn.

Date.	———	Total Number of Bacteria. per c.c.	B. Coli Communis per c.c.	B. Enteritidis Sporogenes.
18 Nov. 1899 -	River Tern - - - - - - - -	—	? any in 1 c.c. -	—
14 March 1900 -	Mill Brook, Uffington - - - - - -	1,390	16	—
14 March „ -	River Tern * - - - - - - -	1,230	2	—
14 March „ -	Cound Brook * - - - - - - -	880	1	—
17 May „ -	Sheinton Brook - - - - - - -	34	3	Absent.
17 May „ -	Mary's Dingle Brook - - - - - -	1,500	Absent	Absent.
17 May „ -	Mill Brook, Buildwas - - - - - -	840	9	?.
31 May „ -	Cressage Brook - - - - - - -	2,600	43	—
31 May „ -	Brook, Eye Farm - - - - - - -	10,566	10	—
31 May „ -	Brook, Belsway Pyne Hall - - - - -	823	26	Present.
31 May „ -	Sheinton Brook - - - - - - -	763	10	—
31 May „ -	Mary's Dingle Brook - - - - - -	915	97	—
	Holy Trinity Brook - - - - - -	4,320	41	—
	Mill Brook, Buildwas - - - - - -	1,502	9	Present.
	Buildwas Junction Brook - - - - -	5,373	—	?.
14 Sept. „ -	Sheinton Brook - - - - - - -	8,100	80	Present.
4 Sept. „ -	Mary's Dingle Brook - - - - - -	3,250	8	Absent.

* These two are by far the largest streams; the others are nearly all certainly contaminated.

TABLE XXVI.

BACTERIOLOGICAL Analysis of Land Drains entering the RIVER SEVERN.

Date.	———	Total Number of Bacteria per c.c.	B. Coli Communis. per c.c.	B. Enteritidis Sporogenes. per c.c.
14 March 1900 -	Left bank, above Penley Rough - - -	3,200	Absent	Absent.
14 March ,, -	Right bank, above Penley Rough - - -	2,600	Absent	Absent.
14 March ,, -	Left bank, above Uffington - - - - -	754	Absent	Absent.
14 March ,, -	Right bank, above Ford - - - - -	1,090	Absent	Absent.
14 March ,, -	Right bank, below Ford - - - - -	1,060	Absent	Absent
14 March ,, -	Right bank, below Railway Bridge No. II. -	2,080	Absent	Absent.
14 March ,, -	Right bank, below Preston - - - -	1,570	25	Present.
14 March ,, -	Right bank, below Atcham - - - -	1,260	Absent	Absent.
14 March ,, -	Left bank, below Bell Brook - - - -	329	Absent	Absent.
14 March ,, -	Left bank, below Wroxeter - - - -	350	19	Absent.
30 March ,, -	Left bank, below Uffington - - - -	110	Absent	Absent.
30 March ,, -	Burton's Tomb - - - - - - - -	965	Absent	Absent.
30 March ,, -	Cotons - - - - - - - - -	110	Absent	Absent.
30 March ,, -	Right bank, Lower Cound Farm - - -	610	Absent	Absent.
12 April ,, -	At Isolation Hospital - - - - - -	1,950	6	Absent.

TABLE XXVII.

BACTERIOLOGICAL Analysis of Mud from the Banks of RIVER SEVERN.

Date.	———		Miles from Waterworks.	B. Coli Communis per gramme.	B. Enteritidis Sporogenes. in 0·1 gramme.
30 March 1900 -	Above Asylum - - - - -	Asylum to Waterworks.	2 (Above)	25	Present.
17 May ,, -	Above Asylum - - - - -			43	Present.
12 April ,, -	Below Asylum - - - - -			1,140	Present.
17 May ,, -	Below Asylum - - - - -			1,600	Present.
	At Waterworks - - - - -			Apparently Absent	Present.
12 April ,, -	Below Waterworks - - - -	Waterworks "Ferry III."		49,000	Present.
17 May ,, -	Ferry I. - - - - - - -		0·6	Absent	Present.
17 May ,, -	At Foundry - - - - -		1·4	52,380	Present.
17 May ,, -	Bay below Railway Bridge - -		2·	432,200	Present.
14 March ,, -	Ferry III. - - - - - - -		2·5	3,320	Present.
14 March ,, -	At Ditherington Drain - - -	"Ferry III." to Uffington.	2·5	10,127	Present.
12 April ,, -	Canal Bridge - - - - -		3·5	1,580	Present.
17 May ,, -	Bay at Canal Bridge - - - -		3·5	100,700	Atypical.
14 March ,, -	Below Preston - - - - -	Uffington to Cressage.	6·3	668	Present.
17 May ,, -	Below Preston - - - - -		6·3	33	Absent.
17 May ,, -	Railway Bridge II. - - - -		5·9	137,100	Atypical.
14 March ,, -	Below Atcham - - - - -		9·	115	Present.
17 May ,, -	Below Atcham sewer - - - -		10·	50	Present.
14 March ,, -	Cressage - - - - - -		16·	2,490	Present.
31 May ,, -	Cressage - - - - - -			100	—
31 May , -	Cockshut Rough - - - - -	From Cressage to Ironbridge.	19·9	50	Present.
	Eye Farm - - - - - -		17·3	50	Present.
	Marnwood Lodge - - - -		21·8	33	Present
	Ironbridge - - - - - -		23·	165	Present.

For methods of Analysis see body of Report.

TABLE XXVIII.

BLES showing the Number of B. Coli per Gramme in the Mud of the Bed of the River Severn, upon 28th Marc and 11th June, 1901.

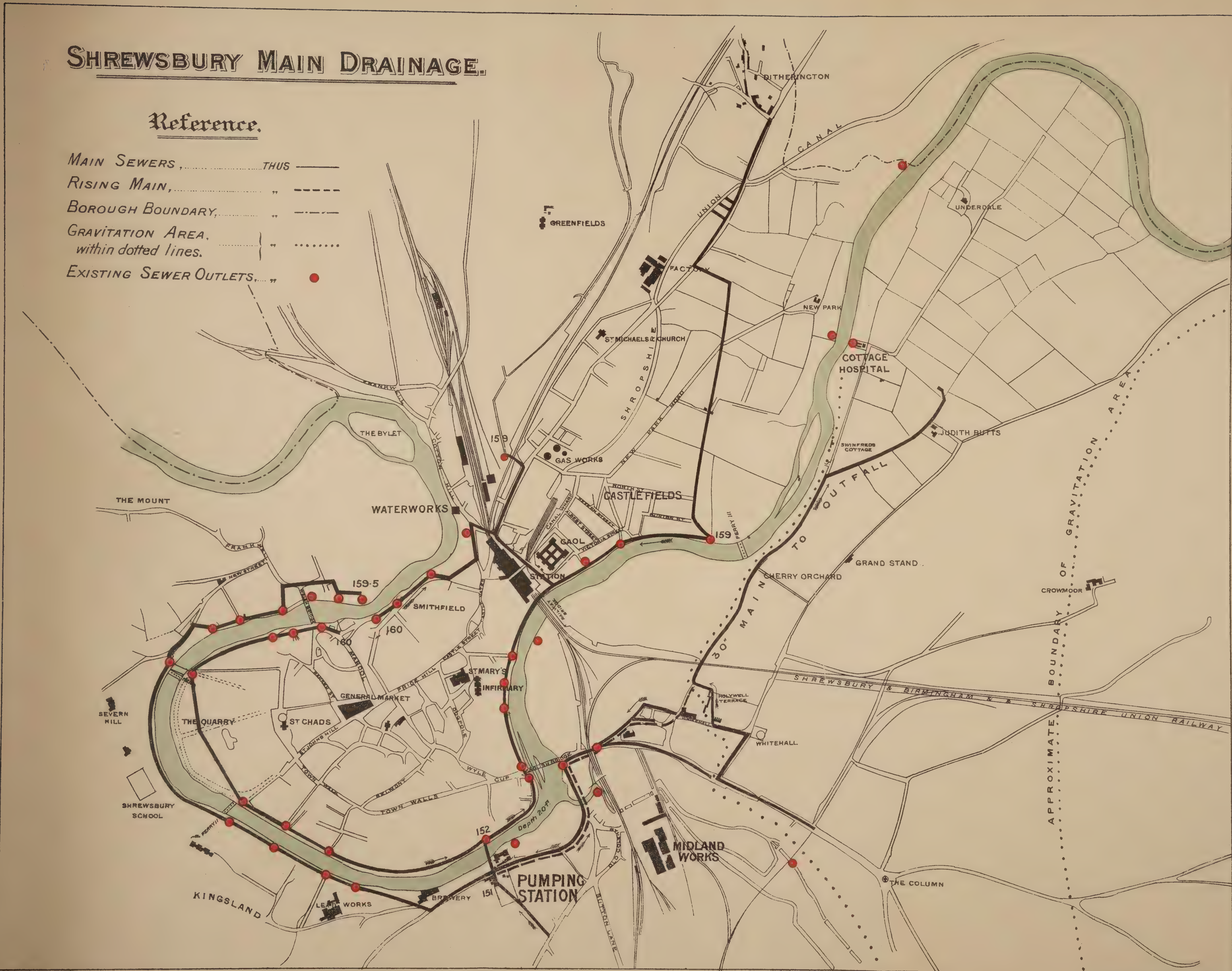
Date.	Where taken.	B. Coli Communis Per Gramme.	Date.	Where taken.	B. Coli Communis Per Gramme.
1901 :			1901 :		
28 March	Above Asylum - - - -	70	11 June -	Asylum - - - - - -	8
	Below Asylum - - - -	30		Waterworks intake - - -	96
	¼-mile lower down - - -	30		Septic Pool opposite to Brewery sewer.	300,000
	Waterworks intake - - -	30		Opposite Park, 50 yards below Ferry I. (deep water) about	12,500
	Just above Waterworks - -	30		Septic Pool above English Bridge (depth 25 feet).	31,500
	Brewery, 1st drain pipe - -	500,000		Below English Bridge - about	6,000
	Brewery sewer - - - -	1,200,000		Ferry III. - - about	17,500
	70 yards below Brewery, mid-stream.	1,300		Uffington - - - - -	4,200
	30 yards in lifebuoy stream, left bank.	1,440		Midway between Uffington and Atcham (depth 13 feet).	195
	Ferry I., midstream - - -	40		Atcham - - - - - -	240
	100 yards above footbridge -	2,240		Cressage (fine sandy bottom) -	90
	Deep pool above English Bridge	44,000			
	Ferry III., left bank - - -	900			
	Ferry III., right bank - -	5,200			

TABLE XXIX.

CHEMICAL EXAMINATION of RIVER SEVERN at SHREWSBURY and Below.

DATE.	———	Asylum.	Water-works.	Ferry III.	Uffington.	Cound.	Cressage.	Below Cressage.	Iron-Bridge.
30 Mar. 1900	Ammoniacal Nitrogen - - - - -	·0004	–	·0120	–	·0031	·0042	–	–
	Albuminoid Nitrogen - - - - -	·0061	–	·0120	–	·0083	·0095	–	–
	Nitrogen as Nitrates - - - - -	·040	–	·028	–	* ·052	·044	–	–
	Total Chlorine - - - - - - -	·984	–	1·106	–	1·114	1·114	–	–
	Total Solids - - - - - - - -	16·40	–	17·60	–	21·92	21·69	–	–
	Oxygen absorbed in 4 hours - - -	·169	–	·200	–	·215	·215	–	–
14 May 1900 -	Ammoniacal Nitrogen - - - - -	·0008	·0102	–	–	–	·0049	·0036	·0037
	Albuminoid Nitrogen - - - - -	·007	·0125	–	–	–	·0139	·0115	·0131
	Nitrogen as Nitrates - - - - -	·034	·040	–	–	–	·036	·054	·064
	Total Chlorine - - - - - - -	1·856	1·998	–	–	–	2·286	2·282	2·282
	Total Solids - - - - - - - -	15 60	16·24	–	–	–	19·68	20·64	19·84
	Oxygen absorbed in 4 hours - - -	·182	·201	–	–	–	·211	·230	·288
14 Aug. 1900	Ammoniacal Nitrogen - - - - -	–	·0036	·0105	·0039	–	–	–	·0088
	Albuminoid Nitrogen - - - - -	–	·0115	·0212	·0173	–	–	–	·0222
	Nitrogen as Nitrates - - - - -	–	·040	·060	·060	–	–	–	·075
	Total Chlorine - - - - - - -	–	1·570	1·606	1·606	–	–	–	1·677
	Total Solids - - - - - - - -	–	11·280	13·040	11·200	–	–	–	15·200
	Oxygen absorbed in 4 hours - - -	–	·340	·344	·385	–	–	–	·397
18 Oct. 1900 -	Ammoniacal Nitrogen - - - - -	·0009	·0029	·0029	·0113	·0083	–	–	–
	Albuminoid Nitrogen - - - - -	·0083	·0100	·0113	·0138	·0148	–	–	–
	Nitrogen as Nitrates - - - - -	·034	·030	·034	·050	·050	–	–	–
	Total Chlorine - - - - - - -	1·498	1·641	1·712	1·641	1·864	–	–	–
	Total Solids - - - - - - - -	9·840	9·520	11·200	9·760	16·320	–	–	–
	Oxygen absorbed in 4 hours - - -	·290	·280	·290	·320	·310	–	–	–
7 Dec. 1900 -	Ammoniacal Nitrogen - - - - -	·0015	–	·0039	·0034	·0029	·0044	–	–
	Albuminoid Nitrogen - - - - -	·0145	–	·0148	·0148	·0173	·0207	–	–
	Nitrogen as Nitrates - - - - -	·060	–	·045	·060	·050	·050	–	–
	Total Chlorine - - - - - - -	·999	–	1·070	1·070	1·070	1·142	–	–
	Total Solids - - - - - - - -	14·000	–	14·200	14·160	13·840	15·360	–	–
	Oxygen absorbed in 4 hours - - - -	0·54	–	·054	·054	·054	·057	–	–

* Above Cound.



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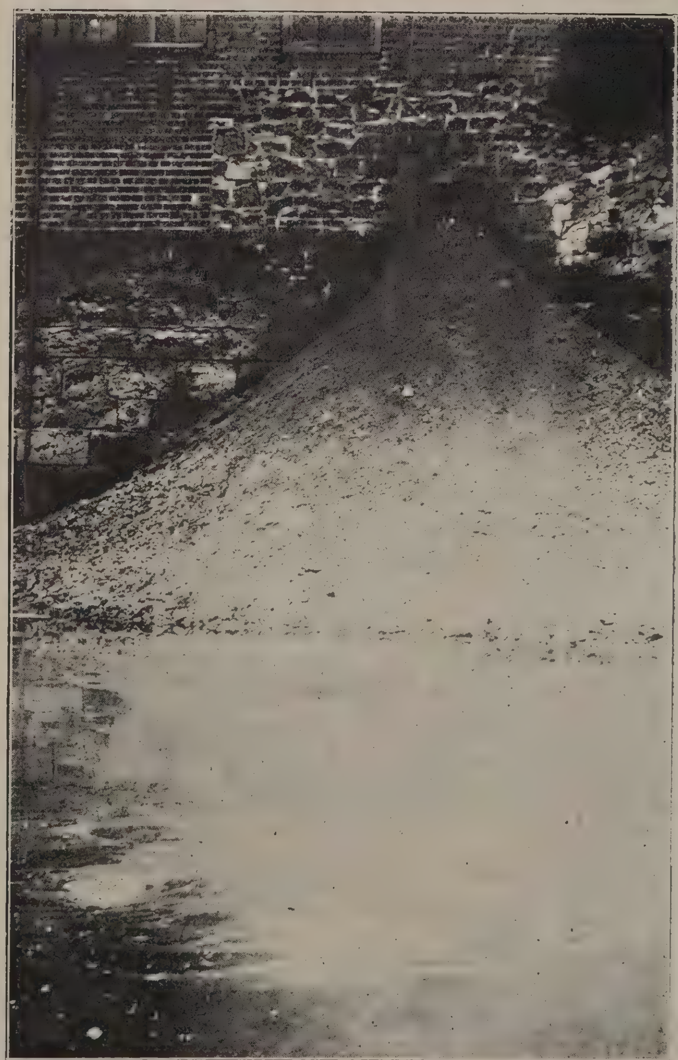
1.
ASYLUM SEWER OUTFALL.

2.
DRAIN ABOVE WATERWORKS.

3.
SHREWSBURY WATERWORKS.

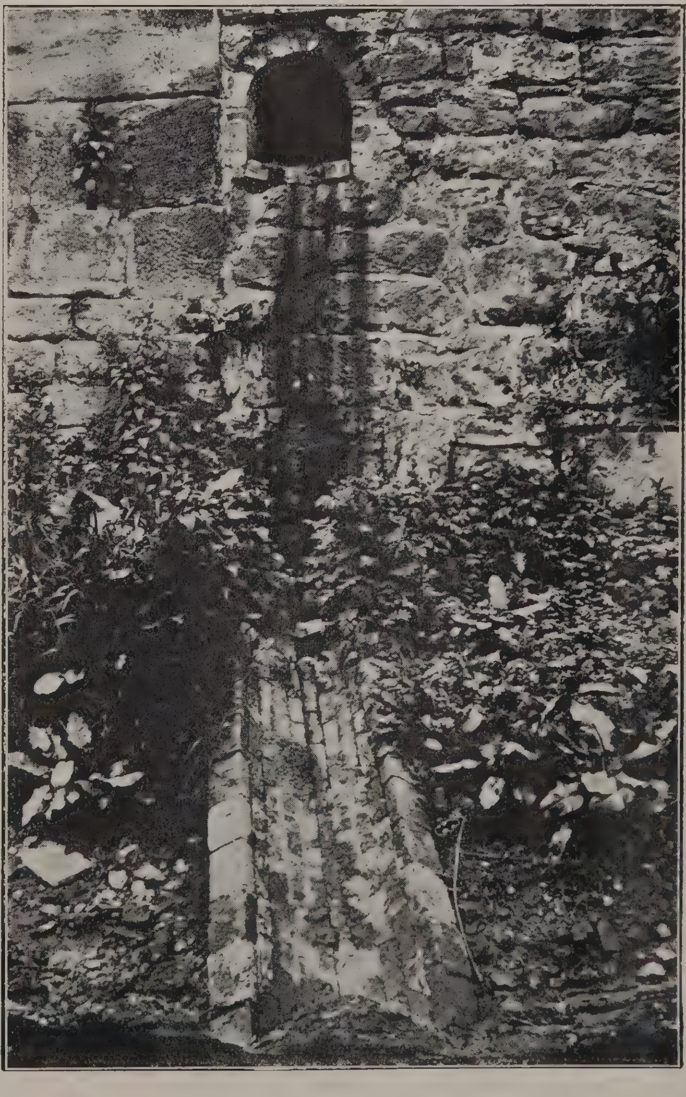


4.
ASH-HEAP JUST BELOW WATERWORKS.

5.
SEWER OPENING JUST BELOW WATERWORKS.

6.
ALLEY, SHORT DISTANCE BELOW WATERWORKS.

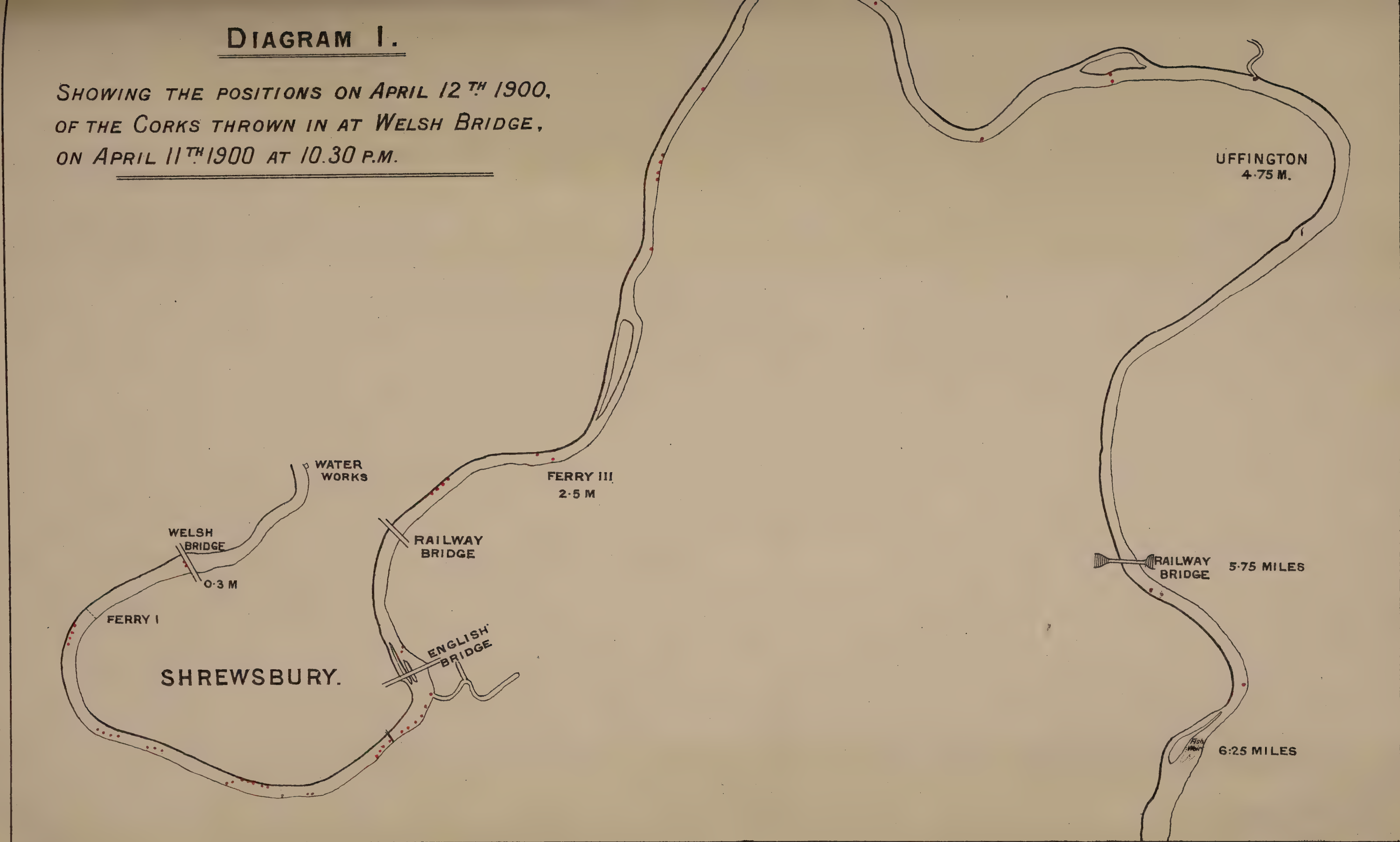
7.
LLECTION OF CORKS BELOW RAILWAY BRIDGE, SHREWSBURY.



8.
SEWER OUTFALL, IRON BRIDGE (RIVER R'GHT IN FOREGROUND).

Diagram I.

Showing the positions on April 12th 1900, of the Corks thrown in at Welsh Bridge, on April 11th 1900 at 10.30 p.m.



3082 4, 02.

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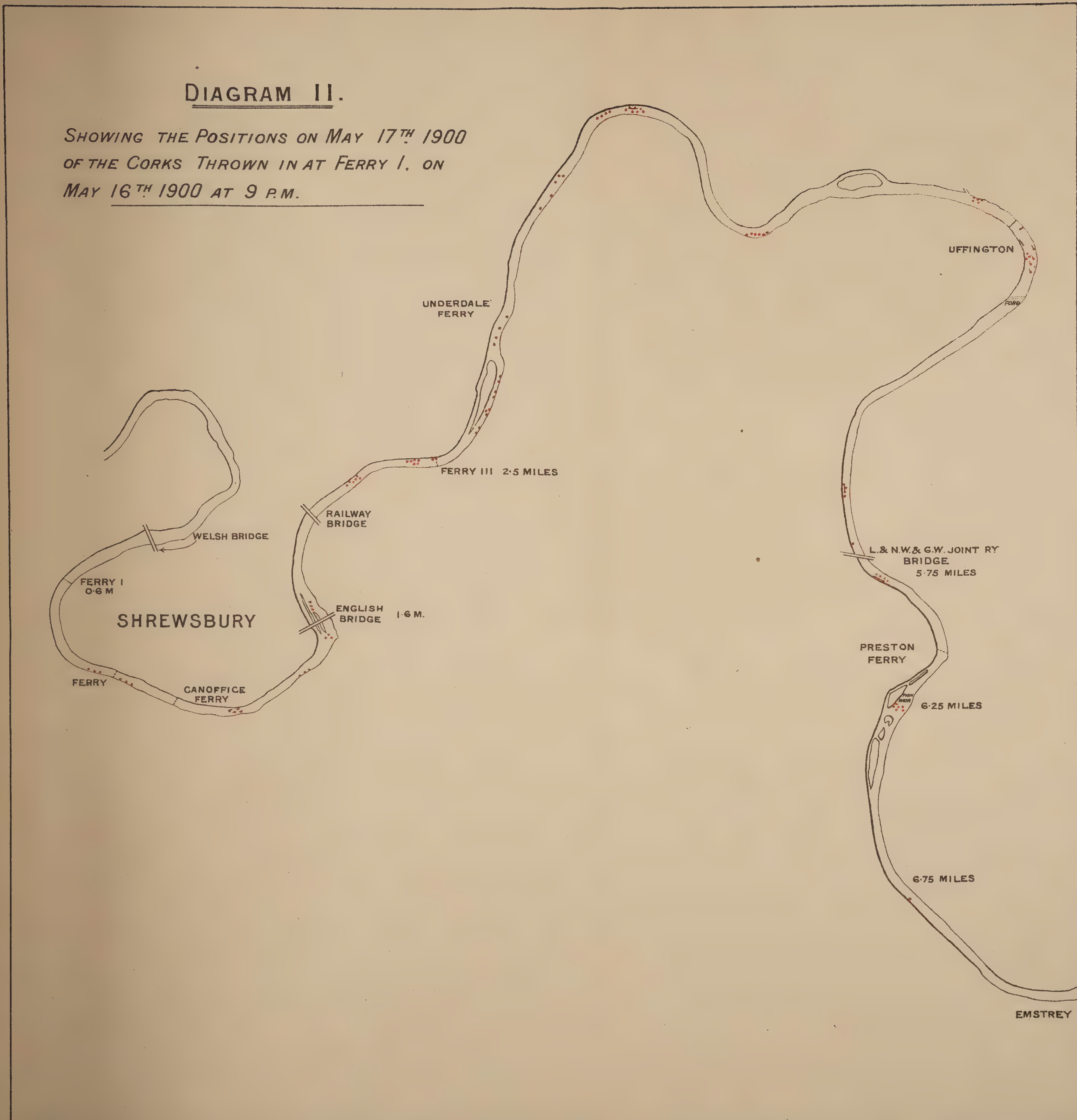

3088. 3.02.

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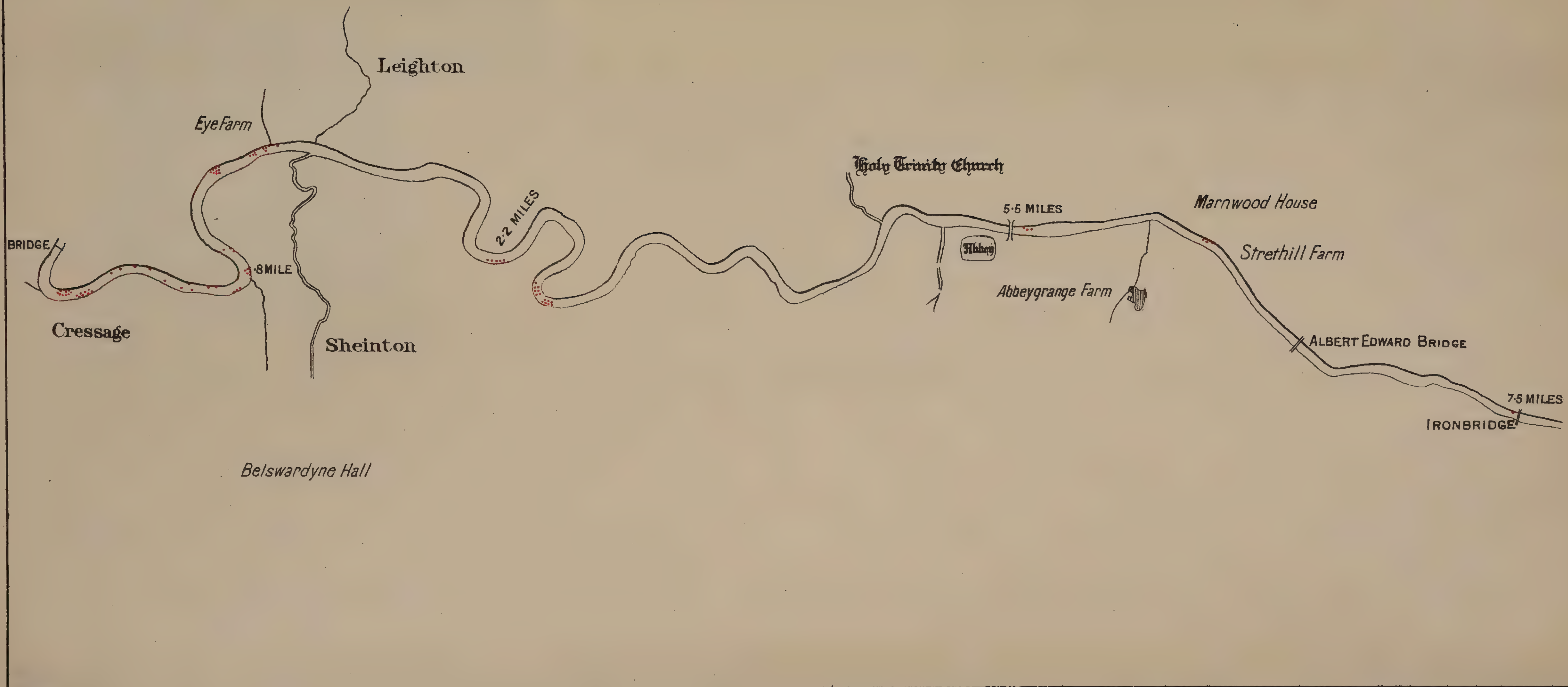
DIAGRAM III.

SHOWING THE POSITIONS ON MAY 30TH 1900 OF THE CORKS THROWN IN AT CRESSAGE ON MAY 29TH 1900, AT 10 P.M.



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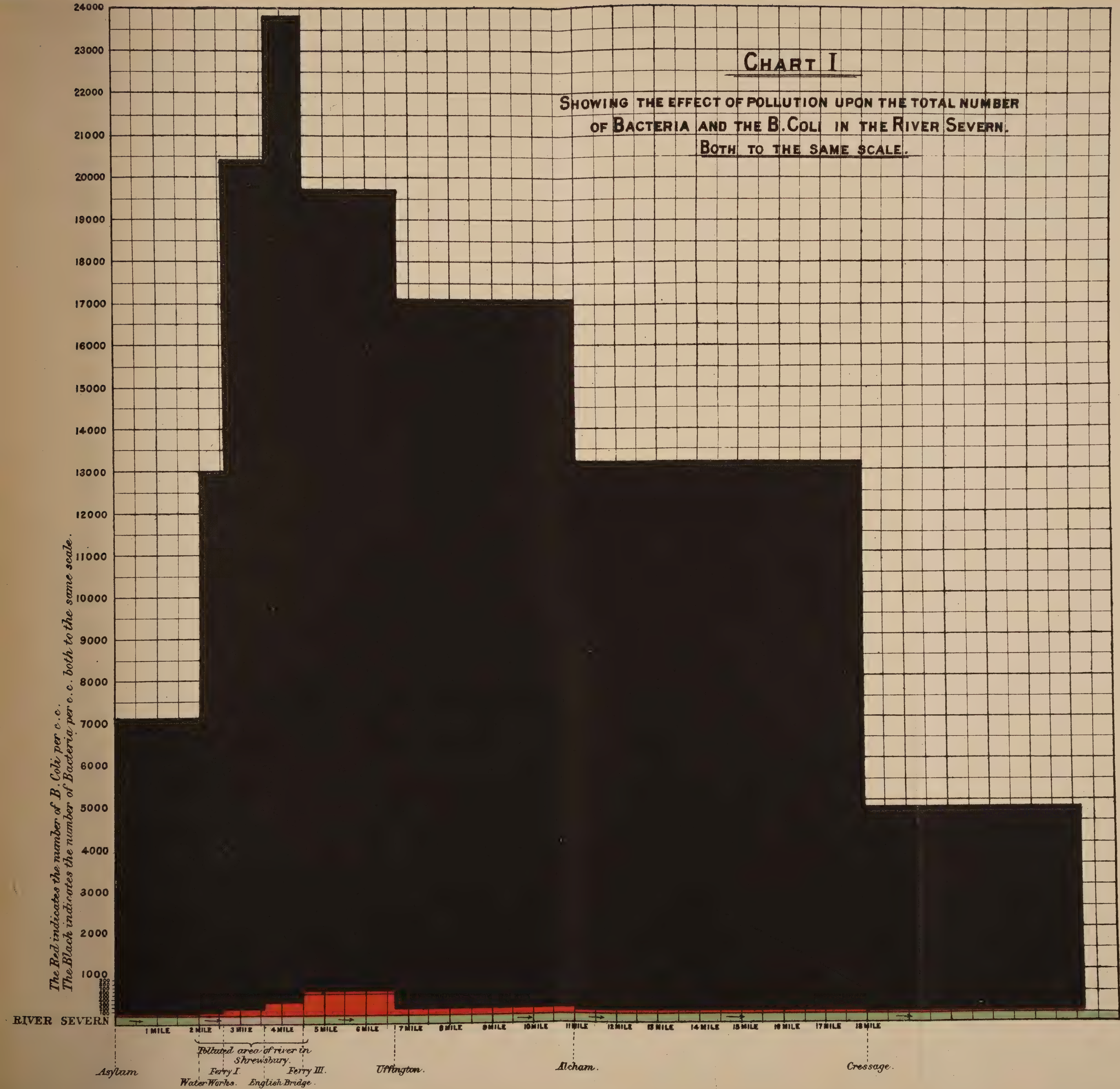

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1065. 6. 01.

CHART II.

SHOWING THE EFFECT OF SEWAGE POLLUTION UPON THE RIVER SEVERN, AS RECORDED BY THE NUMBER OF B. COLI.

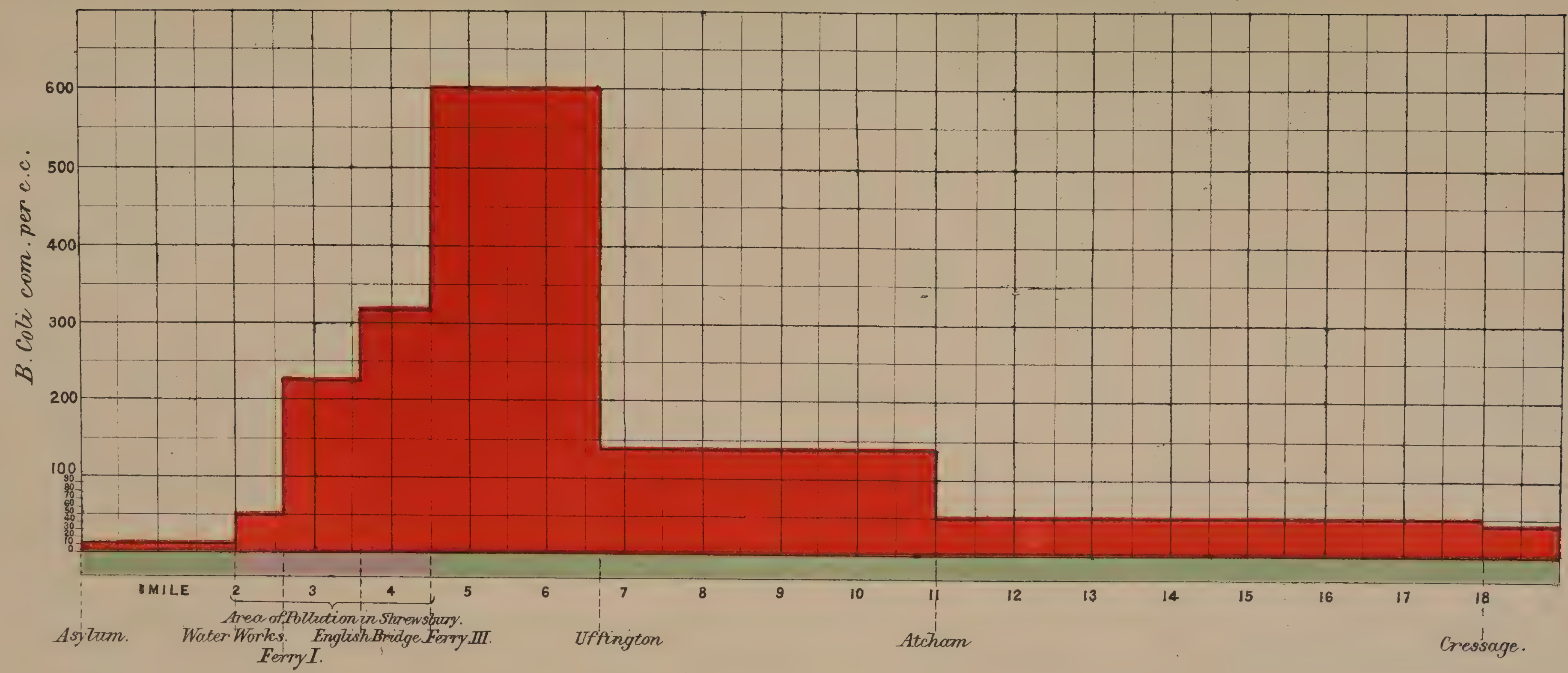

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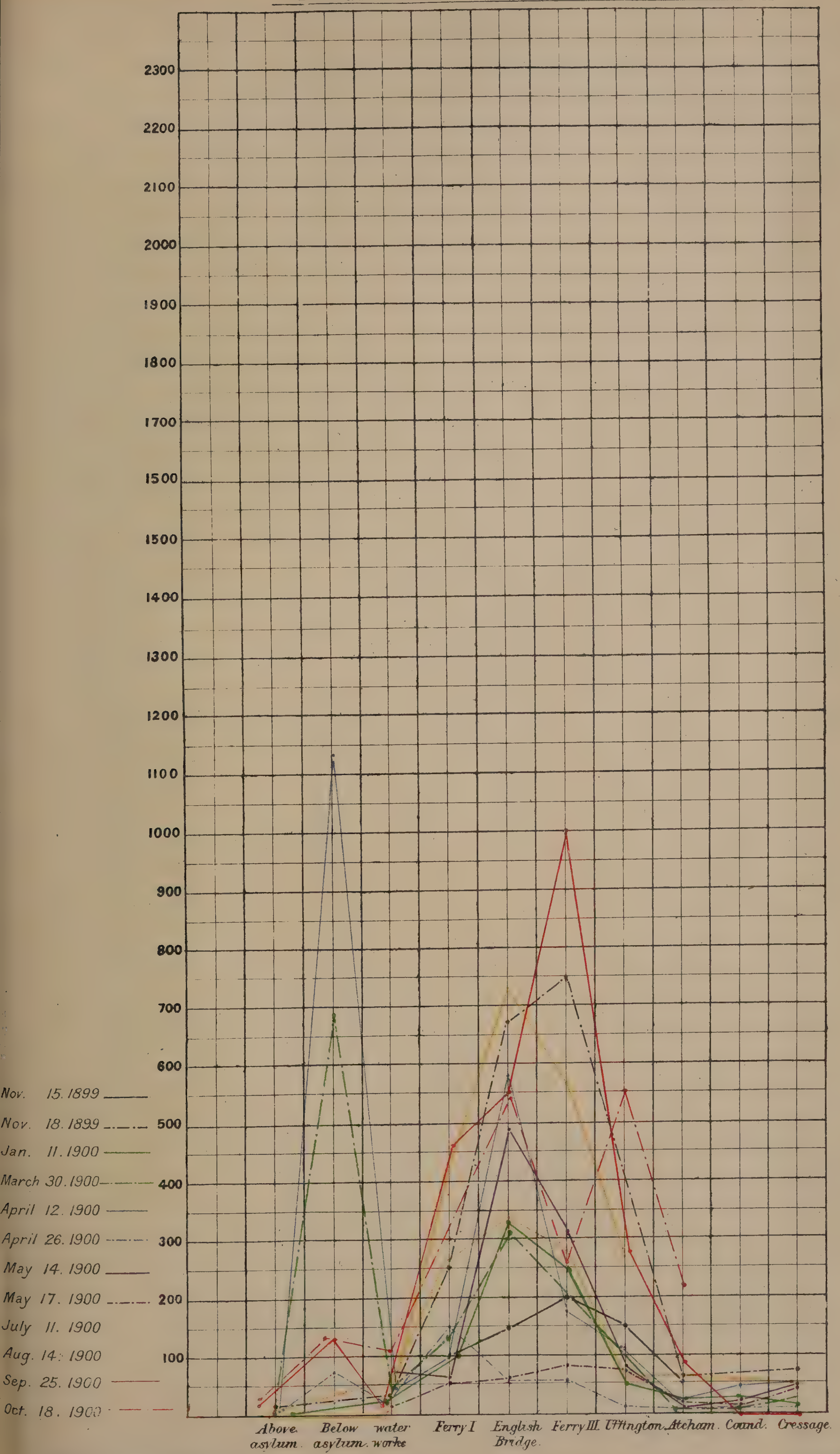
CHART III.

Bacillus Coli Communis. River Severn.



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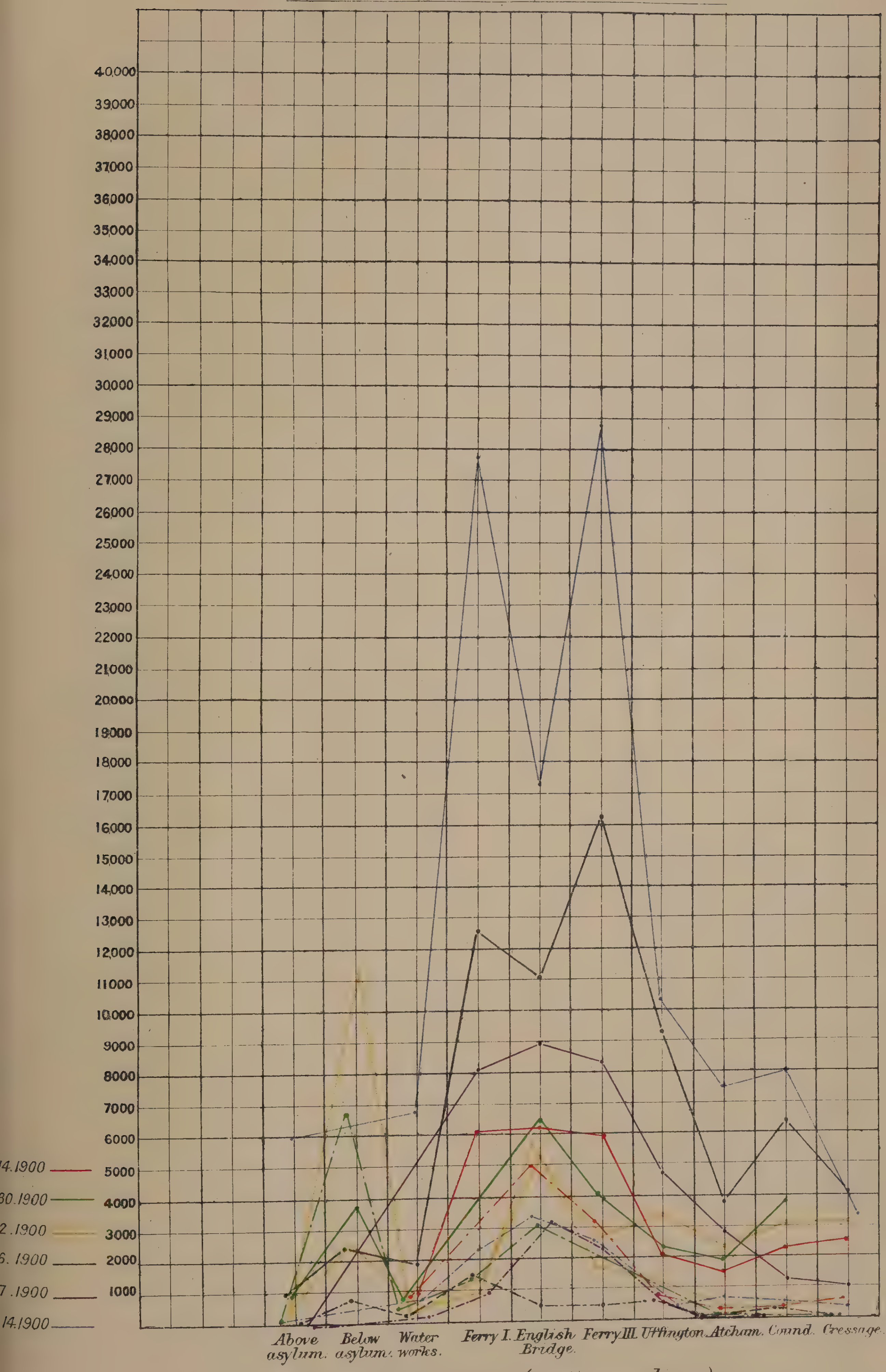
1065.6.01

Chart IV.

River Seven, Shrewsbury.



Total number of Bacteria (continuous line)
B. coli communis (interrupted line), scale 1/10.

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CHART V

RIVER SEVERN, SHREWSBURY.

Curve illustrating superficial & deep bacteriological analyses.

OCTOBER 17TH 1900.
AUGUST 14TH 1900

total number of Bacteria.
" " number of B. coli on

The Green & Yellow lines show
The Black & Red " " Deep

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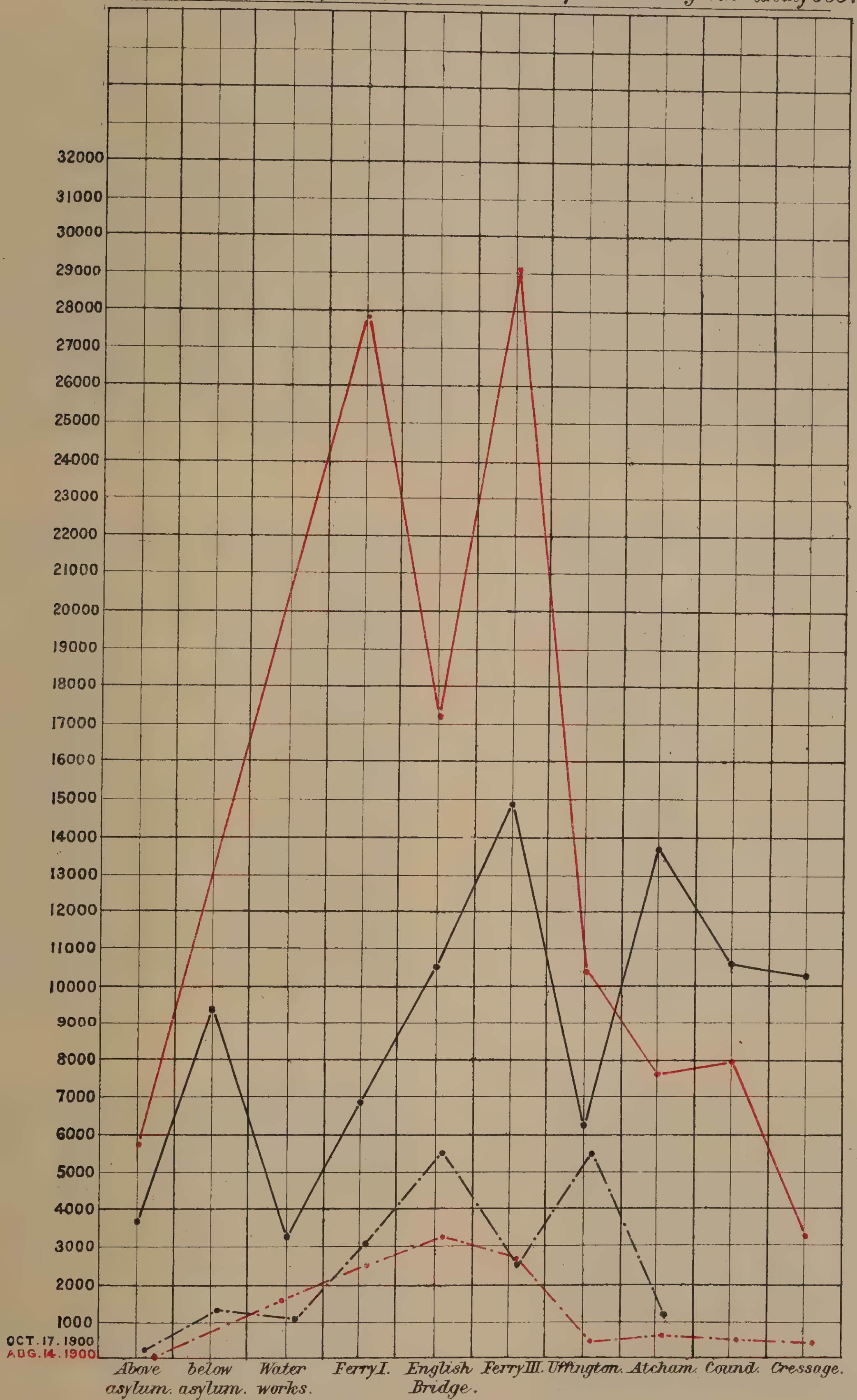
CHART. V.

RIVER SEVERN, SHREWSBURY.

Curve illustrating superficial & deep bacteriological analyses.



OCTOBER 17TH 1900.
AUGUST 14TH 1900.

——— *Continuous lines represent total number of Bacteria*
—·—·— *Interrupted „ „ number of B. coli on 1/10th scale viz: 1000=100.*

The Green & Yellow lines show Superficial Analysis.
The Black & Red „ „ Deep „

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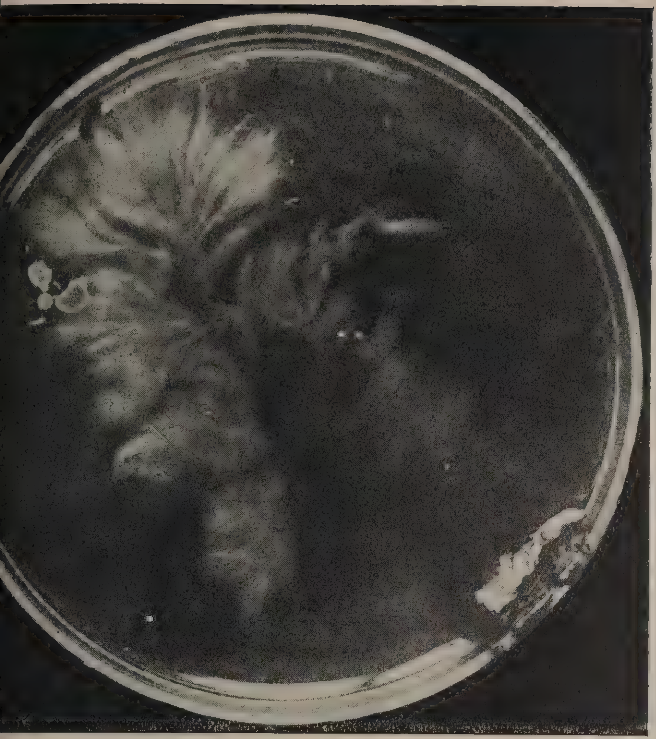
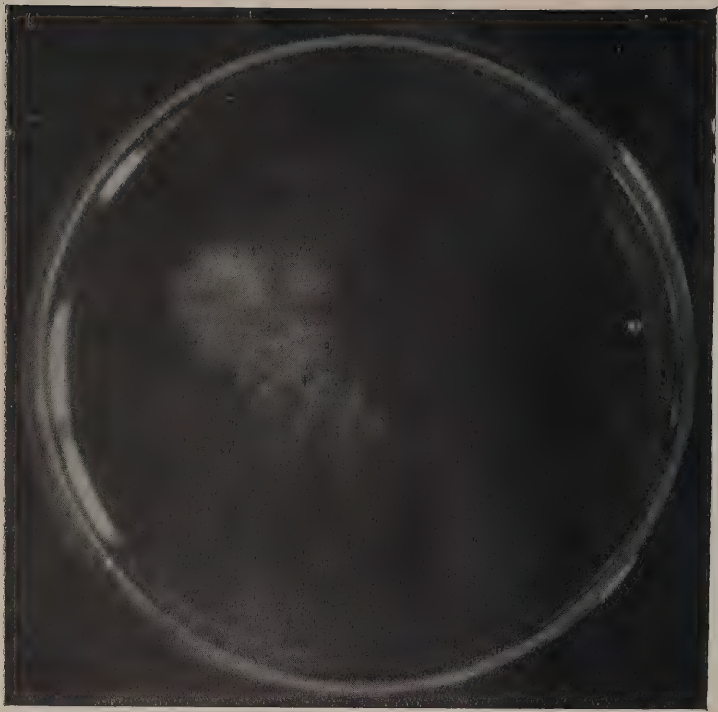
1065.6.01.



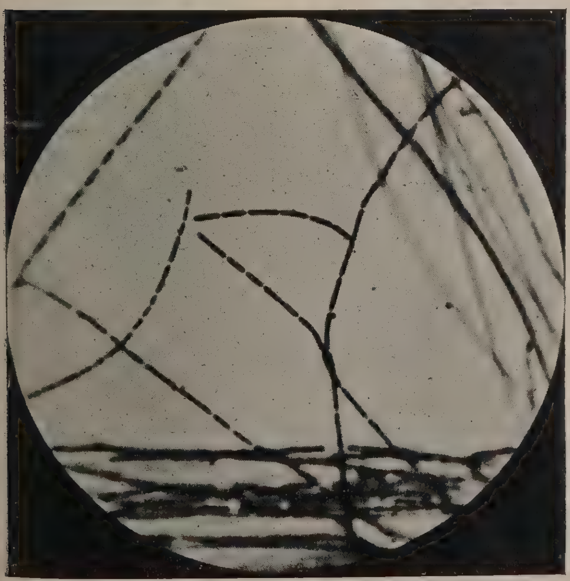
Tuft of *Leptomitus lacteus.* (Natural size).



Tuft of *Sphaerotilus natans.* (Natural size).

Leptomitus lacteus, showing construction and nucleus.
(Zeiss obj. 3 mm.).

Leptomitus lacteus, showing branching.
(Zeiss obj. 3 mm.).



Sphaerotilus natans. (Zeiss obj. 3 mm.).

Carchesium lachmanni (slightly magnified).

NOTE ON THE SELF-PURIFICATION OF THE RIVER SEVERN AS REGARDS ITS CHEMICAL IMPURITIES.

10th March, 1902.

COLIN C. FRYE.

In conjunction with the bacteriological examination of the River Severn, some 30 chemical examinations of its water have been made for the Commission. Apart from the bacteriological connection, however, these examinations have some value as regards the self-purification of the river from its chemical impurities, and it is, therefore, thought worth while to present a note on the subject.

SAMPLING.

The samples of water, taken in mid-stream from a boat rowed slowly down the river, were drawn at the following places:—

(1) Opposite the County Asylum, two miles above the Shrewsbury Waterworks.

(2) Opposite the waterworks intake, just inside the township of Shrewsbury.

(3) At Ferry III., 2·5 miles from the waterworks, and near the end of Shrewsbury.

(4) At Uffington, a village 4·75 miles below the waterworks.

(5) At Atcham, a village 9 miles below the waterworks.

(6) Cound, a few houses 13 miles from the waterworks.

(7) Cressage, a village 16 miles from the waterworks.

The samples were drawn at intervals of about one month, from March to December, 1900.

POLLUTION.

In 1896 the normal dry-weather flow of the Shrewsbury sewage was estimated at 844,000 gallons per 24 hours, so that at the present time (1900) the flow will probably be somewhat more than that. The whole of this sewage enters the river (at a large number of places) in an untreated state, and becomes mixed with, roughly, 100 times its volume of river water.

The sewage is a domestic one, but contains some waste liquors from a brewery and a candle factory. The villages of Uffington, Atcham, and Cound also pollute the river, but in a minor degree, and not sufficiently to obscure the purification of the Shrewsbury sewage.

There are also four brooks which discharge their waters into the Severn below Shrewsbury and above Cressage; but they are comparatively clear, and will therefore help rather than retard the recovery of the river from its contact with Shrewsbury.

RESULTS.

The results, stated in as brief a manner as possible, are as follows:

If the increase or pollution in ammoniacal and albuminoid nitrogen which occurs where water of known composition reaches Shrewsbury be taken as 100, then the loss or decrease of ammoniacal and albuminoid nitrogen in the water as it proceeds down the river will represent the percentage recovery from that pollution. Calculations made in this manner on the nitrogen values in the present analyses give the following figures:

March 1900.

Waterworks to Cound.—Distance 13 miles.

—	Waterworks.	Ferry III.	Cound.	Purification.
				Per cent.
Ammoniacal Nitrogen - - - -	·0004	·0120	·0031	77
Albuminoid Nitrogen - - - - -	·0061	·0120	·0083	38

April 1900.

Waterworks to Atcham.—Distance 9 miles.

—	Waterworks.	Ferry III.	Atcham.	Purification.
				Per cent.
Ammoniacal Nitrogen - - - -	·0028	·0085	·0059	81
Albuminoid Nitrogen - - - - -	·0071	·0105	·0069	106

May 1900.

Waterworks to below Cressage.—Distance about 17 miles.

—	Waterworks.	Ferry III.	Cressage.	Purification.
				Per cent.
Ammoniacal Nitrogen - - - -	·0008	·0102	·0036	75
Albuminoid Nitrogen - - - - -	·0070	·0128	·0115	21

August 1900.

Waterworks to Uffington.—Distance 4·75 miles.

—	Waterworks.	Ferry III.	Uffington.	Purification.
				Per cent.
Ammoniacal Nitrogen	·0036	·0105	·0039	96
Albuminoid Nitrogen	·0115	·0012	·0173	41

December 1900.

Waterworks to Cound.—Distance 13 miles.

—	Waterworks.	Ferry III.	Cound.	Purification.
				Per cent.
Ammoniacal Nitrogen	·0015	·0029	·0029	42
Albuminoid Nitrogen	·0145	·0148	·0173	none.

NOTE.—The river was in flood when this sample was drawn.

If the other items of the chemical analysis are studied in the same way, similar results are obtained, and the conclusion is therefore that the Severn water shows a marked recovery from its Shrewsbury pollution within some 20 miles from the town.

No figures showing absolute recovery from organic pollution can be given because of the further pollution which occurs as it proceeds, but two sets of analysis, not included above, of the water below Cressage (18 to 25 miles below Shrewsbury) have shown that the water still further recovers lower down.

The water at Cressage itself, however, has, at each examination, shown evidences of chemical deterioration, and the recovery of the river from the Shrewsbury pollution is, therefore, rendered difficult to follow below this point.

NOTE.—The reason for here selecting the unoxidised nitrogen (more correctly, part of the unoxidised nitrogen) values as giving typical figures for the measurement of chemical pollution, is, that the other tests are more liable to be affected by weirs, errors in sampling, delay between drawing and analysing, etc., and are much less easy to follow.

The conclusions are drawn from the complete analysis which are given in the appendix.

COLIN C. FRYE.

Complete ANALYSES of River Severn Water made during 1900.

30th March 1900.

—	Asylum.	Ferry III.	Cound.	Cressage.
Ammoniacal Nitrogen	·0004	·0120	·0031	·0042
Albuminoid Nitrogen	·0061	·0120	·0083	·0095
Nitrate Nitrogen	·040	·028	·052	·044
Total Chlorine	·984	1·106	1·114	1·114
Total Solids	16·40	17·60	21·92	21·69
Oxygen absorbed in 4 hours	·169	·200	·215	·215

30th April 1900.

—	Waterworks.	Ferry III.	Atcham.
Ammoniacal Nitrogen	·0028	·0085	·0039
Albuminoid Nitrogen	·0071	·0105	·0069
Nitrate Nitrogen	·040	·057	·044
Total Chlorine	·973	1·068	1·068
Total Solids	15·040	16·800	16·000
Oxygen absorbed in 4 hours	·126	·174	·155

14th May 1900.

—	Asylum.	Waterworks.	Cressage.	Below Cressage.	Trowbridge.
Ammoniacal Nitrogen	·0008	·0102	·0049	·0036	·0037
Albuminoid Nitrogen	·007	·0125	·0139	·0115	·0131
Nitrate Nitrogen	·034	·040	·036	·054	·064
Total Chlorine	1·856	1·998	2·286	2·282	2·282
Total Solids	15·60	16·24	19·68	20·64	19·84
Oxygen absorbed in 4 hours	·182	·201	·211	·230	·288

14th August 1900.

——	Waterworks.	Ferry III.	Uffington.	Trowbridge.
Ammoniacal Nitrogen - - - - - - -	.0036	·0105	·0039	·0088
Albuminoid Nitrogen - - - - - - -	·0115	·0212	·0173	·0222
Nitrate Nitrogen · - - - - - - -	·040	·060	·060	·075
Total Chlorine - - - - - - - -	1·570	1·606	1·606	1·677
Total Solids - - - - - - - -	11·280	13·040	11·200	15·200
Oxygen absorbed in 4 hours - . - - ·	·340	·344	·385	·397

18th October 1900.

——	Asylum.	Waterworks.	Ferry III.	Uffington.	Cound.
Ammoniacal Nitrogen - - - -	·0009	·0029	·0029	·0113	·0083
Albuminoid Nitrogen - - - -	·0083	·0100	·0113	·0138	·0148
Nitrate Nitrogen - - - - -	·034	·030	·034	·050	·050
Total Chlorine - - - - -	1·498	1·641	1·712	1·641	1·864
Total Solids - - - - - -	9·840	9·520	11·200	9·760	16·320
Oxygen absorbed in 4 hours - - -	·290	·280	·290	·320	·310

NOTE.—The figures in this Analysis are not considered reliable, as several of the bottles, containing the samples, were broken when received.

7th December 1900.

——	Asylum.	Ferry III.	Uffington.	Cound.	Cressage.
Ammoniacal Nitrogen - - - -	·0015	·0039	·0034	·0029	·0044
Albuminoid Nitrogen - - - -	·0145	·0148	·0148	·0173	·0207
Nitrate Nitrogen - - - - -	·060	·045	·060	·050	·050
Total Chlorine - - - - -	·999	1·070	1·070	1·070	1·142
Total Solids - - - - - -	14·000	14·200	14·160	13·840	15·360
Oxygen absorbed in 4 hours - - -	·054	·054	·054	·054	·057

Report on some of the chief methods used in the Bacteriological Examination of Sewage and Effluents.

By Dr. Houston.

The following account of some of the chief methods used in the bacteriological analysis of sewage and effluents, although based on prolonged study not only of the bacteriology of sewage, but also of soils, soil "washings," and water supply, is not to be regarded as a final statement. The subject is a progressive one, and this report aims only at reviewing our knowledge at the present time.

Great attention has, for obvious reasons, been paid to the subject of simple tests. But it is to be hoped that these simple tests, however convenient they may prove in carrying out routine work, will not become the unfortunate means of checking original research on old established lines, and, by seeking to make work more easy, tend to retard advance of our existing imperfect knowledge.

It is to be noted that this report deals only with domestic sewage, or with sewage containing trade refuse in amount not sufficient to *alter seriously* its biological composition.

Some mention should be made of the successive dilutions of tenths, the decimal method of making dilutions, and stating results. The object sought to be attained is to render the bacteriological results more intelligible, and at the same time comparative and definite in character. In the past, the practice has commonly been to speak of the mere presence or absence of particular microbes in a sample, or at best of their presence or absence when using a definite quantity of the substance examined. Only in quite recent years has any serious attempt been made to imitate biologically the precise, accurate and quantitative investigations of the chemist. Bacteriology can perhaps never vie with chemistry in this respect, but taking into account the much greater range of most bacteriological tests, the errors of judgment based on experiment are reduced to a minimum. Thus the range of the albuminoid ammonia test (that is the difference in the amount of albuminoid ammonia in the substances sought to be brought into comparison, *e. g.* sewage, and sewage effluents and water) is, although very considerable, not so great as to allow of slipshod methods of chemical analysis. Compare this with the range of the B. coli test, which shows the presence of this microbe in $\frac{1}{100,000}$ c.c. of sewage, and may show its absence from as much as 100 c.c. of a pure water. So wide a distinction as is here indicated would go far to cover any errors incidental to biological methods. There can be little doubt that the progress of bacteriology has been greatly hampered by inattention to this question of the relative abundance of microbes of the same species in substances of different sort, *e. g.* sewage and potable water, polluted and non-polluted streams, manured and virgin soils, etc. It is true that there are difficulties of an almost insuperable character in carrying out these investigations, but even approximate data are of value in this connexion, and in certain directions quantitative results may be obtained bacteriologically with comparative ease. For example, instead of determining the presence or absence of B. enteritidis sporogenes or B. coli in sewage and effluents, or even whether these microbes are present or absent from a definite amount of these substances, it is almost as easy and certainly more valuable to estimate their relative abundance. If successive dilutions of tenths or the decimal method of making dilutions and recording results be employed for this purpose, the results of the examination of a fairly satisfactory effluent would be likely to be as follows :—

(1.) B. enteritidis sporogenes (Klein's "enteritidis change" in anaerobic milk cultures) test :—

+ 1 c.c. ; — ·1 c.c. (at least 1 in the c. c., but less than 10).

(2.) B. coli test:—

+ ·01 c.c. ; — ·001 c.c. (at least 100 in the c.c., but less than 1,000).

Another and less satisfactory effluent might yield results as follows :—

(1.) B. enteritidis sporogenes.

+ ·1 c.c. ; — ·01 c.c. (at least 10 in the c.c., but less than 100).

(2.) B. coli :—

+ ·001 c.c. ; — ·0001 c.c. (at least 1,000 in the c.c., but less than 10,000).

On the basis of these tests the second effluent is ten times worse than the first.

It may definitely be said that unless attention is directed to this matter no real comparison can be drawn between sewage and effluents of varying degrees of purity, between effluents and the rivers into which they are being discharged, between drinking water streams and non-drinking water streams. It is to be regretted that in the past, waters have been condemned by bacteriologists owing to the mere presence in them of bacteria believed to be of sewage origin without any reliable records being available of the relative abundance of these same bacteria in sewage.

It will be noted that in connection with each proposed bacteriological test the subject of standards has been touched on, but it must be understood that the standards suggested are provisional ones and apply only to non-drinking water streams. I may here repeat the views I have previously expressed on this subject. In the case of non-drinking water streams I consider the chemical results of primary, and the bacteriological results of secondary importance, except in special cases and when oysters and shell fish are concerned. It may be said, why then have any bacteriological standard at all? But it does not follow that, because a thing is at the present time of

secondary value, it should therefore receive no consideration. If bacteriological standards can be brought into harmony, made parallel as it were, with chemical results, they may serve a most useful purpose, and chemical knowledge is perhaps not so advanced as to render the supplementary aid to be obtained from bacteriology a matter of indifference. Moreover, be it noted, that the utility of standards need not necessarily be solely, if at all, for legislative purposes. They may be used for working purposes merely and as a means for the ready comparison of effluents of varying degrees of purity.

As regards the discharge of sewage effluents into drinking water streams, the relative positions of the chemist and bacteriologist are reversed, and here the only absolutely safe bacteriological standard is a sterile effluent. But as this is probably impracticable, *partial sterilisation involving the destruction of B. coli* may be considered a reasonably safe standard. As I have stated elsewhere from my own experiments I am satisfied that this standard can be reached at a not unreasonable cost.

The following is a brief summary of the contents of the report :—

A.—Collection of samples.

B.—Dilution.

Section I.—Bacteriological tests and suggested standards.

1. Total number of bacteria.
   (*a*) Gelatine at 20° C.
   (*b*) Agar at 37° C.
2. Number of liquefying bacteria.
3. Number of spores of aerobic bacteria,
4. B. coli.
   (*a*) Surface gelatine plate cultures.
   (*b*) Primary broth and secondary gelatine plate cultures.
5. Indol test.
6. Spores of B. enteritidis sporogenes.
7. Streptococci.
8. Anaerobic bacteria.
9. Thermophilic bacteria.
10. H_2S bacteria.
11. Inoculation of animals.

Section II.—Simple bacteriological tests and suggested standards.

12. Gas test.
13. Litmus milk test.
14. Neutral red broth test.
    5. Indol test
    6. B. enteritidis sporogenes test } already considered.
15. Bile-salt broth test.
16. Litmus milk (modified) test.

Section III.—Summary and Conclusions.

C.—Table showing the successive dilutions of tenths or the decimal method of recording results together with certain bacteriological standards of a provisional kind.

D.—Description of micro-photographs and illustrations accompanying the report.

A.—Collection of Samples.

Glass stoppered bottles should be used, and the bottles may be sterilised : (*a*) by means of dry heat (150° C. for one hour); or (*b*), by rinsing first with pure nitric acid, then repeatedly with sterile water until no trace of acid remains, and finally with absolute alcohol, a trace of alcohol being left in the bottle. The bottle should next be rinsed at least three times with the sample and then filled completely full, the stopper being then inserted with a circular twisting movement to avoid the inclusion of small air bubbles. The sample should be examined as soon after collection as possible where the object is to ascertain the actual number of total or particular microbes present in it, but the urgent necessity for an immediate examination has been somewhat exaggerated. Satisfactory effluents—effluents free from an undue amount of oxidisable and putrescible matter—are not seriously affected by a reasonable delay taking place between the time of collection and subsequent examination of the sample. In the case of foul effluents, however, the multiplication of the micro-organisms present may be considerable. Such effluents would in any case fail to pass any reasonable standard of purity, and it may be of advantage to

emphasise their objectionable qualities. This circumstance might possibly even be used as a basis for a test of the degree of putrescibility of effluents; that is, pure effluents on keeping a given number of hours would be apt to show a smaller percentage increase in the number of total or particular microbes than impure effluents kept for the same time under similar conditions. Having regard to the importance of showing if possible the *potential* putrescibility of effluents and the amount of assimilable pabulum still remaining in them and so capable of assisting bacterial multiplication, the actual numbers as ascertained by immediate examination may be less important than observation of the number after keeping a sample a fixed number of hours. On the whole after mature consideration I am inclined to advocate the examination of effluents 24 hours after their collection. This no doubt would lead to a greater bacterial multiplication in warm as compared with cold weather, but it is also the case that it is chiefly during summer months that our rivers are at their lowest and that putrefaction and nuisance are most complained of.

B.—Dilution.

The number of bacteria in sewage and most sewage effluents is so enormous that it is necessary largely to dilute the samples with definite quantities of sterile water. There is no generally agreed upon method of making the necessary dilutions, but the following plan will be found to be most satisfactory* :—

Take five small conical Erlenmeyer's flasks, and add to each one 90 c.c. of water. Plug the flasks with cotton wool and sterilise in the steam steriliser at 100° C. for one hour on two successive days. Label the flasks (1), (2), (3), (4), (5). †To flask (1) add 10 c.c. of the sample by means of a 10 c.c. sterilised pipette, and shake thoroughly. With a 10 c.c. sterilised pipette withdraw 10 c.c. of the liquid from flask (1) and add them to flask (2) and shake thoroughly. In the same way withdraw 10 c.c. of the contents of flask (2) and add them to flask (3). Add 10 c.c. from flask (3) to (4), and finally 10 c.c. of (4) to (5). Dilution may, of course, be carried still further, but for ordinary purposes the above is quite sufficient. In this way a series of dilutions are obtained having the following respective values :—

Successive dilutions of tenths or decimal method of making dilutions for bacteriological purposes :—

Flask (dilution). 1	Flask (dilution). 2	Flask (dilution). 3	Flask (dilution). 4	Flask (dilution). 5
90 c.c. H_2O+10c.c sample 100 c.c. = 10 c.c. ,, 10 c.c. = 1 c.c. ,, 1 c.c. = {0·1 c.c. ,, / $\frac{1}{10}$ c.c. ,,}	90 c.c. H_2O + 10 c.c. (1) 100 c.c. = 1 c.c. sample 10 c.c. = 0·1 c.c. ,, 1 c.c. = {0·01 c.c. ,, / $\frac{1}{100}$ c.c. ,,}	90 c.c. H_2O + 10 c.c. (2) 100 c.c. = 0·1 c.c. sample 10 c.c. = 0·01 c.c. ,, 1 c.c. = {0·001 c.c. ,, / $\frac{1}{1000}$ c.c. ,,}	90 c.c. H_2O + 10 c.c. (3) 100 c.c. = 0·01 c.c. sample 10 c.c. = 0·001 c.c. ,, 1 c.c. = {0·0001 c.c. ,, / $\frac{1}{10,000}$ c.c. ,,}	90 c.c. H_2O + 10 c.c. (4) 100 c.c. = 0·001 c.c. sample 10 c.c. = 0·0C01 c.c. ,, 1 c.c. = {0·00001 c.c. ,, / $\frac{1}{100,000}$ c.c. .}

It is to be noted that this method of making the dilutions presents certain obvious advantages. By using 1 c.c. of the various dilutions, beginning with the highest dilution and working down to the lowest, a series of cultures are obtained, each one of which contains one-tenth less of the samples than the one immediately below it in the scale of dilutions. This may be exemplified as follows :—

1 c.c. (1)	1 c.c. (2)	1 c.c. (3)	1 c.c. (4)	1 c.c. (5)
= ·1 c.c.	·01 c.c.	·001 c.c.	·0001 c.c.	·00001 c.c.
= $\frac{1}{10}$ c.c.	$\frac{1}{100}$ c.c.	$\frac{1}{1000}$ c.c.	$\frac{1}{10,000}$ c.c.	$\frac{1}{100,000}$ c.c.
10 per c.c.	100 per c.c.	1000 per c.c.	10,000 per c.c.	100,000 per c.c.

Thus a positive result with 1 c.c. (3) and a negative result with 1 c.c. (4) would read :—

+ ·001 c.c. ($\frac{1}{1000}$ c.c.); — ·0001 c.c. ($\frac{1}{10000}$ c.c.).

At least 1,000 but less than 10,000 per c.c.

This successive dilutions of tenths or decimal method of obtaining records and stating results has been used, notably as regards B. coli and spores of B. enteritidis sporogenes, throughout the whole course of the investigation. All the results obtained from the commencement of the work up to the time of writing this report (December 1901) are thus strictly comparable.

Section I.—Bacteriological tests and suggested standards.

1. *Total number of bacteria.*

The total number of bacteria should be estimated in gelatine at 20° C. and in agar at 37° C. It is important to possess a record of the number of bacteria in a sample capable of growing at blood heat. Sewage, as might be anticipated, is extremely rich in intestinal germs, most of which grow luxuriantly at a temperature of 37° C. Both actually and relatively to the total bacterial flora, as estimated in gelatine at 20° C., sewage is rich in microbes capable of growing in agar at 37° C. Pure waters, on the other hand, are apt to contain very few microbes able to grow in agar at 37° C., and hence the small actual number of such microbes, and the small number

* From the very commencement of the work for the Commission this method was used, as I had previously found it to be of considerable value.

† Plate I., Fig. A.

relative to the total number as estimated by the gelatine method, affords some criterion of purity But it is erroneous to regard the presence of a large number of microbes in agar plate cultures at 37° C.—either actually large or large in relation to the number growing in gelatine at 20° C.—as conclusive evidence of objectionable contamination without due note being taken of the kinds of bacteria present. Soils and soil "washings" are peculiarly rich both actually and relatively to the total bacterial flora (gelatine at 20° C.) in microbes capable of growing luxuriantly at 37° C. This is true not only as regards polluted soils, but also with respect to soils which seemingly bear no relation to contamination, at all events of recent sort. It is even true as regards reputedly virgin soils. Yet the great majority of these bacteria belong to species believed to be quite harmless. With sewage the case is different, because a large proportion of the total number of microbes capable of growing in agar at 37° C. are of intestinal origin, and if not themselves pathogenic have what may be termed a pathogenic significance, inasmuch as they are apt at any time to be accompanied by other bacteria clearly related to disease in man and the lower animals.

Too much reliance must not be placed on the estimation of the total number of bacteria. Although a useful indication of the probable biological quality of a liquid, cases may arise when a rigid reliance on the value of this test might lead to serious error. Koch has unwittingly fostered an unthinking faith in the value of estimation of total numbers as a criterion of purity. In examining water containing very many thousands of bacteria per c.c. he found that by efficient sand filtration its numbers were reduced to less than 100 per c.c. His conclusion was that as a practical test of the efficiency of sand filtration, numbers might be taken as a most useful guide. That, if a water containing many thousand bacteria per c.c. was found after sand filtration to contain less than 100 per c.c., such a filtered water might be regarded as reasonably safe for potable purposes. It may be inferred that Professor Koch meant relatively safe, not necessarily actually so. Koch's views have, however, been interpreted wrongly, and his conclusions read erroneously. It is now the practice of many bacteriologists to condemn all samples of water containing more than 100 bacteria per c.c., and to pass those yielding less than 100 microbes in 1 c.c. This too without relation to their source and independently of a study of the kinds of bacteria present in them. In my own experience, I have examined waters containing 10 or less microbes per c.c. which in my judgment were more to be suspected in their possible relation to disease than some other waters containing 1,000 or more in 1 c.c

Nevertheless estimation of total numbers is a test of considerable value, provided reasonable care is exercised not to confuse inferences with facts, and provided also the results obtained are interpreted in a judicious manner. Past bacteriological records are nearly all founded on enumeration of the total bacterial flora in a sample, and notwithstanding the progress of bacteriology it seems unwise altogether to abandon tests which may serve to link the old order of things with the new. On the other hand, the records under this heading are now so numerous that possibly in the future the test of "total numbers" may be dispensed with.

Procedure :—

(*a*) *Gelatine at* 20° C.

Sewage :—To each of four sterilised 10 c.c. gelatine tubes add severally by means of sterilised 1 c.c. pipettes 1 c.c. from flasks 2, 3, 4, 5, representing respectively 0·01 ($\frac{1}{100}$; × result by 100) c.c. ; 0·001 ($\frac{1}{1000}$; × result by 1,000) c.c. ; 0·0001 ($\frac{1}{10000}$; × result by 10,000) c.c. ; 0·00001 ($\frac{1}{100000}$; × result by 100,000) c.c. Place the tubes in warm water (about 35° C.) until the gelatine is melted, and then make plate cultures in the ordinary manner. When the gelatine has become solid invert the plates and incubate at 20° C. After 24 hours it is usually necessary to turn the plates back to their original position owing to the presence of liquefying colonies.*

Example.—The number of colonies in the gelatine plate made with 1 c.c. of 4 dilution is found to be 100 ; 100 × 10,000 = 1,000,000 microbes per c.c.

The more plates made the better, but the important point is to make sure of having one plate at least which contains neither too many nor too few colonies. By the above method a "workable" plate is always secured, no matter how greatly the samples may vary from time to time.

Effluents.—In the case of bad effluents use the same dilutions as for sewage, but in the case of good effluents it may be advisable to use 1 c.c. of dilutions (1), (2), (3), (4).

Gelatine as a medium has certain disadvantages, but many micro-organisms which are practically indistinguishable in agar cultures may be readily differentiated from each other in gelatine cultivations.

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* It is impossible to lay down as a fixed rule when the plates should be counted. Some bacteriologists count on the second day, others on the third day or later, and the incubating temperature varies in different laboratories. Others again have no fixed time, but count at as late a date as the overcrowding of the colonies and the progressive liquefaction of the gelatine will allow. If we decide always to count the plate cultures after incubation at a definite temperature on a definite day, the following difficulty arises. Some samples contain a relatively large number of quickly growing and rapidly liquefying colonies which may spoil the plate cultures for counting purposes long before the set time for counting has been reached ; other samples may contain a relatively large number of very slowly growing non-liquefying colonies. Here one is forced to count the plates before many of the colonies are fairly developed ; in other words too soon to obtain the absolute number. If all samples contained the same kinds of bacteria (liquefying and non-liquefying, rapidly growing and slowly growing) in the same relative proportion, the best way to obtain *comparable* results would doubtless be to count the plates after the lapse of a definite number of hours incubation at a given temperature, although how many hours and at precisely what temperature would still be questions open to dispute. But this is far from being the case, and so it is incorrect to say that comparable results are always obtained by counting after a definite number of hours. As the matter stands about as much may be said on the one side as the other.

Fig. 1 Plate II. shows the number of bacteria in 1 c.c. of 5 dilution ($\frac{1}{100000}$ c.c.) Rugby settled sewage, sample 224. This sample contained 7,300,000 microbes per c.c. (gelatine at 20° C.).

(*b*) *Agar at* 37° C.*

Sewage.—Here agar instead of gelatine is used as a nutrient medium, and the plates are incubated at 37° C. instead of 20° C. As a rule it is best to work with 1 c.c. of dilutions (1), (2), (3), (4).

Effluents.—Bad effluents may be treated in the same manner, but in the case of good effluents use 1 c.c. direct of the liquid and 1 c.c. of dilutions 1, 2, 3.

As regards standards, a good effluent should contain less than 100,000 (gelatine at 20° C.) and less than 10,000 (agar at 37° C.) bacteria per c.c.

Fig. 2. Plate II. shows the number of bacteria in 1 c.c. of 3 dilution ($\frac{1}{1000}$ c.c.) Rugby settled sewage, sample 224. This sample contained 820,000 microbes per c.c. (agar at 37° C.).

Fig. 3. Plate II. shows the number of bacteria in 1 c.c. of 4 dilution ($\frac{1}{10000}$ c.c.) Nottingham sewage, sample 329. This sample contained 4,040,000 microbes per c.c. (agar at 37° C.).

Fig. 4 Plate II. shows the number of bacteria in 1 c.c. of 2 dilution ($\frac{1}{100}$ c.c.) Nottingham land effluent, sample 332. This sample contained 4,700 microbes per c.c. (agar at 37° C.). The remarkable reduction in the number of bacteria in this sample as compared with the crude sewage (Fig. 3) is noteworthy.

Many bacteriologists now prefer to use standardised media. If the bacteria grow as well in these media as in the media prepared in the old fashioned way there is no reason why they should not be used. But the experimental error involved in the numerical estimation of bacteria is so great, the personal equation plays so strong a part in determining the results, and the conclusions to be drawn from a knowledge of total numbers are of so little value unless they be interpreted in the broadest spirit possible, that questions of standardising media are probably of small importance. In the study of the biological characters of different bacteria with a view to their identification the standardisation of media may prove more useful, although even here the importance of the subject has been unduly exaggerated. No two workers have the same quality of mind, or the same way of looking at things, or of placing on record their observations. These are matters which, operating on a subject like bacteriology, are apt to override and swamp the trivial disparity of results produced by working with media which may vary slightly in composition from time to time.

2.—*Number of Liquefying Bacteria.*

At one time it was thought to be the case that the greater the number of liquefying bacteria in a liquid the stronger was the evidence of objectionable pollution. But pure waters are rich in harmless rapidly liquefying species (*e.g.*, B. fluorescens liquefaciens), and sewage, although containing many liquefiers, is also rich in non-liquefiers (*e.g.*, B. coli) of objectionable kind. Nevertheless, when the character of the liquefying microbes is taken into consideration the test becomes of some value. Thus, crude sewage not only contains many liquefying forms but many of the liquefiers are of undesirable sort. For example, it is not uncommon to find in from $\frac{1}{10000}$ to $\frac{1}{100000}$ c.c. of sewage gas-forming rapidly liquefying proteus-like microbes, which on injection into guinea-pigs prove virulent in twenty-four hours or less.

As regards standards, I am not prepared to make any definite suggestion in connection with this test.

Procedure:—

Sewage.—The gelatine plates for total numbers may be used for estimating the number of liquefying microbes, but as many of the colonies remain imbedded in the gelatine and so do not display their liquefying power, this method is open to objection. A better plan is to pour four gelatine plates and allow the gelatine to set. Then inoculate them severally with 0·1 c.c. of dilutions (1), (2), (3), (4). In each case spread the liquid over the surface of the gelatine by means of a sterilised platinum "spreader." Invert the plates and incubate at 20° C. After twenty-four hours turn the plates back to their original position. On the second or third day, or even later, count the number of colonies liquefying the gelatine.

Example.—The number of colonies liquefying the gelatine in the 0·1 c.c. of (3) dilution plate is found to be 9. 9 × 10,000 = 90,000 liquefiers per c.c.

Effluents.—Bad effluents may be treated in the same way, but in the case of good effluents use 0·1 c.c. direct and 0·1 c.c. of dilutions (1), (2), (3).

3.—*Number of Spores of Aerobic Bacteria.*

For a number of reasons it is important to know the number of spores of aerobic bacteria in sewage and effluents, but this test, like the foregoing one, cannot perhaps be considered of primary importance. The number of spores of aerobic bacteria in sewage is usually less than 1,000 per c.c., with a total bacterial flora of over one million. It is of interest to contrast these figures with the number found in soils and soil "washings." In soils the number of spores both actually and

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* Some bacteriologists prefer to incubate their cultures at 42° C. In no spirit of captious criticism it may be pointed out that as 37–38° C. is the temperature of the body the use of a higher temperature for incubation purposes may introduce an additional element of uncertainty into our methods of bacteriological analysis, which already are of an artificial kind. It may, for example, conceivably be the case that both pathogenic and non-pathogenic intestinal microbes when separated from the animal body learn to some extent to adapt themselves to a comparatively low temperature, and that if they be suddenly transplanted perchance in a state of feeble vitality into a medium incubated at a much higher temperature than blood heat the change may be too abrupt to allow of their multiplication. Nevertheless, the practical advantages of the higher temperature may over-ride any seeming objections.

relatively to the total number of microbes is far in excess* of the number found in sewage. Many soils contain from 10,000 to 100,000 or more spores per gramme, and the ratios of spores to total numbers is apt to lie between 1 : 2 and 1 : 10 †

As regards standards I am not prepared to make any definite suggestion in connection with this test.

Procedure :—

Sewage and Effluents:—Inoculate four sterilised 10 c.c. gelatine tubes severally with 1 c.c. direct of the liquid, and 1 c.c. of (1), (2), (3) dilutions. Heat the tubes to 80° C. for ten minutes, and then make plate cultures in the usual way. When the gelatine has set invert the plates and incubate at 20° C. After 24 hours turn the plates back into their original position.

Example.—The number of colonies in the 1 c.c. of 1 dilution plate is found to be 50. 50 × 10 = 500 microbes present in the form of spores per c.c.

4.—*B. Coli (and closely allied forms).*

In February, 1898, I advocated the extreme importance of testing crude sewage and the effluents from sewage purification processes *quantitatively* for B. coli. Briefly stated the chief arguments to be advanced in favour of this test are the following :—

B. coli is an intestinal microbe, not perhaps peculiar to excremental matters, but certainly extremely characteristic of the intestinal discharges of human beings and the lower animals in the sense of being present in these objectionable substances in enormous numbers. In crude sewage ‡ it is usually present in $\frac{1}{100000}$ c.c.

B. coli is a non-sporing microbe, which, although more hardy than such pathogenic bacteria as B. typhosus, and the cholera vibrio is by no means a highly resistant micro-organism.

It is well-known that the excreta of typhoid fever and cholera patients are apt to contain in large number the specific microbes of these epidemic diseases, and such excreta are therefore infectious in minimal amount. Accompanying these and other pathogenic micro-organisms of intestinal sort B. coli is always to be found in great abundance. To demonstrate the presence of disease germs must always be a matter of extreme difficulty, but to estimate the number of B. coli in a liquid is comparatively easy. As an index, then, of the *possible* presence of pathogenic bacteria of intestinal outcome the quantitative estimation of B. coli is a test of singular value.

Some strains of B. coli are pathogenic to animals and are also related to morbid processes occurring in the human subject. But in the present state of our knowledge it would seem unwise to base the value of the test on the assumption that B. coli is *directly* injurious. A safer view is the one set forth in the preceding paragraph, namely, that the quantitative estimation of B. coli is an *indirect* means of measuring the *status* of an effluent in its possible relation to disease.

B. coli is not abundant everywhere in nature. In various reports to the Local Government Board I have shewn that the wide distinction as regards B. coli between crude sewage and pure water, polluted streams and non-polluted rivers, virgin soils and contaminated soils, the "washings" of pure and impure soils, and in general pure as compared with impure substances, is a wide one. B. coli is either altogether absent or relatively absent from pure substances, and is present in sewage and substances recently fouled with excremental matters in enormous numbers.

That B. coli is present in the intestinal discharges of the lower animals cannot reasonably be adduced as an argument against the employment of the test. There is no reliable evidence to show that the excreta of healthy much less of diseased animals are altogether harmless to man.

In conclusion it may be urged that sewage ought always to be regarded as a liquid potentially dangerous. By framing biological standards, as regards the number of B. coli in crude sewage, we are in a position to judge the probable biological *status* of sewage effluents in their relation to danger to health when similarly tested. It is true that conditions may arise in the purification of sewage inimical, if not destructive, to some at all events of the microbes of epidemic disease which may yet exercise little or no deleterious action on B. coli. But it is well to err on the safe side in matters affecting health, and the presence in an effluent of B. coli in any great number ought most certainly to be taken as meaning the possible presence as well of other micro-organisms also of intestinal origin but of more dangerous sort. No effluent, for example, teeming with microbes belonging to the class of B. coli should be considered as having become so modified bacteriologically as to allow of its safe introduction into a stream to be used for drinking purposes.

As a measure then of the probable biological *status* of an effluent in relation to disease, the B. coli test, in my judgment, is one of especial importance.

The standard suggested in the case of non-drinking water streams is less than 1,000 B. coli per c.c. It must be admitted that all the suggested standards, if considered in relation to the chemical results, press with perhaps undue severity on the artificial processes of sewage disposal as compared with treatment on land.

Procedure :—

B. coli may be readily *isolated* from the gelatine or agar plates used for estimating the total number of bacteria. But as in cultures of this sort a large proportion of the colonies remain imbedded in the medium and so do not grow in a typical fashion it is impossible accurately to *estimate the number* of B. coli in this manner. Judging from my experience of the bacteriological

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* Reports of the Medical Officer, Local Government Board, 1897—1900.

† The ratios of aerobic spores to bacteria in the Barking and Crossness experiments was 1 to 11,744 and 1 to 9,662 respectively.

‡ I am here speaking of domestic sewage, or domestic sewage mixed with trade refuse to a moderate extent only. It is not asserted that trade refuse by itself necessarily contains B. coli in abundance, or that domestic sewage mixed with trade refuse of such a nature or amount as to be capable of altering the biological composition of the mixed liquid need of necessity conform to normal sewage standards as regards B. coli. A liquid in which trade refuse is present in much larger proportion than domestic sewage should, I think, not be spoken of as sewage without some qualifying statement.

examination of soil, sewage, and water, the following methods are most to be relied on for estimating the number of B. coli in a substance. *It may be pointed out that no test based on observation of a change or changes produced in the nutrient medium and supposed to be characteristic of B. coli can compare with isolation in plate cultivations of the microbes suspected to be B coli, and the subsequent attentive study of the biological characters of pure cultures of these bacteria when grown in various media.*

*A.—Surface Gelatine Plate Cultures.**

Tubes, each containing 10 c.c. of sterile gelatine, are placed for a few minutes in warm water (about 40° C.) and the liquid contents poured into a series of sterile Petri dishes. When the gelatine has set, the plates are separately inoculated with definite quantities of the liquid to be tested. A sterilised platinum spreader† is used in each case to spread the liquid over the surface of the gelatine. The plates are next inverted and incubated at 20° C. *All* the colonies develop on the free surface and therefore *all* of them display their characteristic modes of growth. Colonies resembling B. coli in their manner of growth are next subcultured in broth (for diffuse cloudiness and indol formation); litmus milk (for acidity and clotting); and gelatine shake cultures (for "gas" formation).

This method I believe to be the best when the object is to study the characters of all the different races of B. coli present in a substance, as well as to estimate their relative abundance. Many bacteriologists add phenol ‡ to the gelatine, and there is no objection to this method provided that the amount added does not exceed 0·05 per cent. To add a larger quantity not only stunts the growth of the colonies of B. coli, but also, I am convinced, destroys the vitality of the weaker members of the group. Surface *agar* plate cultures (with or without the addition of phenol) may be used instead, but I am strongly of opinion that gelatine is the best medium.

Procedure :—

It is safest in the case of sewage to inoculate four plates severally with 0·1 c.c. of dilutions (2), (3), (4), (5). Bad effluents require the same dilutions, but fairly satisfactory effluents should receive 0·1 c.c. of dilutions (1), (2), (3), (4), and good effluents 0·1 c.c. of the liquid direct and 0·1 c.c. of dilutions (1), (2), (3).

> Example :—The number of colonies in the 0·1 c.c. of (3) dilution plate indistinguishable from B. coli is found to be 10. These in subculture in broth, litmus milk, and gelatine "shake" cultures are shewn to be B. coli or closely allied microbes. 10 × 10,000 = 100,000 B. coli (or closely allied forms) per c.c.

C.—Primary broth and secondary surface gelatine plate cultures.

This method is one of extreme delicacy, and perhaps its only fault is that the preliminary growth in broth is apt to "draw out" a particular strain of B. coli at the expense of other accompanying strains. But when the primary object of an investigation is to determine the number of B. coli present, the study of all the different strains of B. coli being considered of secondary importance, this method is probably unsurpassed.

Early in the enquiry Dr. Gordon made a careful and thorough comparison of the chief methods employed in the estimation of B. coli in sewage and sewage effluents, and he came to the conclusion that for the purposes of the present investigation the primary broth and secondary plating method was the best. With this conclusion I am in close agreement, and it needs to be added that the records under the heading of B. coli, which are of a most exhaustive and valuable nature, must be placed to Dr. Gordon's credit. Phenol may be added to the broth and gelatine, but in neither case should it exceed in amount 0·05 per cent. Its addition is certainly not necessary, and so perhaps should not be recommended. §

Procedure :—

Sewage.—Inoculate four sterilised 10 c.c. broth tubes severally with 1 c.c. of dilutions (2), (3), (4), (5). Incubate at 37° C. for 24–48 hours. From those tubes showing abundant diffuse cloudiness make surface gelatine plate cultures as follows:—Inoculate, from one of the primary broth tube cultures by means of a straight platinum needle, a tube (a) containing 10 c.c. of sterile water. Shake the tube (a) and withdraw from it two to four loopfuls, successively using for this purpose a platinum needle with a loop, and add them to the solid surface of 10 c.c. of sterile gelatine previously set in a sterile Petri's dish. Spread the liquid all over the surface of the gelatine by means of a sterile platinum "spreader." Invert the plates and incubate at 20° C. On the second day study the appearance of the colonies, and subculture one or more of those resembling B. coli in broth, litmus milk and gelatine ("shake") cultures.

In the case of bad sewage effluents proceed as above. With fairly satisfactory effluents use 1 c.c. of dilutions (1), (2), (3), (4). In the case of good effluents inoculate the broth tubes with 1 c.c. direct and 1 c.c. of dilutions (1), (2), (3), (4).

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* Fig. 5. Plate III.

† The platinum spreader introduced by Dr. Klein is shown in Fig. E. Plate V.

‡ The addition of phenol to agar, gelatine or broth, is a very old method. Dr. Klein, for example, has used it for more than ten years. Some bacteriologists use a relatively large quantity, others a very small amount. It is significant that most workers of note tend to use less rather than more as their experience widens, and that many bacteriologists who in the past used phenol in greater or less amount now use it no longer.

§ It is well to remember that pathogenic microbes of intestinal outcome must needs, when separated from the animal body, be exposed to influences of a novel and probably uncongenial kind. In consequence their vitality is apt to be weakened, and the addition to nutritive media of substances, which at the best only inhibit these specialised germs to a *less degree* than their saprophytic neighbours, is a dangerous factor to trifle with, and if pushed to excess may defeat the very object sought to be attained—namely, the coaxing back to active existence of enfeebled germs of pathogenic sort. Figs. 6, 7, 8. Plate III.

Example.—Four broth tubes were severally inoculated with 1 c.c. of dilutions (2), (3), (4), (5). After 48 hours' incubation at 37° C. tubes (2), (3), (4)—but not (5)—showed uniform turbidity. Surface secondary gelatine plate cultures were next made from the primary broth tubes (2), (3), (4), showing uniform turbidity, and also from tube (5) as an extra precaution, and incubated at 20° C. On the second day each of the secondary gelatine plate cultures (2), (3, (4) contained nearly pure cultures seemingly of B. coli, but plate (5) contained no colonies liable to be mistaken for B. coli. One or more of the colonies from plate (4) were next subcultured and studied in broth, litmus milk and gelatine ("shake") cultures, and found to be typical of B. coli. Plate (4) corresponds to broth (4), and therefore to $\frac{1}{10000}$ c.c. Result at least 10,000 but less than 100,000 B. coli per c.c.

5.—*Indol Test.—Indol in Broth Cultures.*

(Five days at 37° C.)

Indol is a substance produced during the putrefactive and offensive decomposition of albuminous matters. And indol-producing bacteria (notably B. coli and its allies) are peculiarly abundant in excremental matters and relatively absent from pure waters* and virgin soils. It is obvious that by estimating the numbers of indol-forming microbes in sewage and effluents information of an extremely useful kind is likely to be obtained. On May 18th, 1898, I sought to ascertain the smallest amount of Crossness crude sewage and of the effluent from the 4 feet coke-bed capable of producing growth, offensive smell, and indol when sown in peptone broth. It was found that in both cases so minute a quantity as one-millionth (but not one ten-millionth) c.c. sufficed to give rise to an offensive smell and indol formation in broth cultures. Since then I have used the test with success in the bacteriological examination of waters and soils. But it was Dr. Gordon who drew my attention to the probable value of this test in connection with our routine work for the Commission, and the credit of carrying out a prolonged series of experiments dealing with some hundreds of samples is his due. Although the test is not a specific one as regards B. coli there can be no doubt that in the case of sewage and effluents the records obtained by the use of the indol and B. coli tests show a striking parallelism. *But apart from the value of the demonstration of this important relationship between the two tests, it is in my opinion most desirable that the Commission should possess records of the relative abundance of indol-producing bacteria of all sorts in sewage and sewage effluents.*

The standard suggested in connection with this test is that an effluent should be "passed" even if it gives a positive result with $\frac{1}{100}$ c.c. provided it gives a negative result with $\frac{1}{1000}$ c.c.

It is specially to be noted that all the standards suggested are merely provisional ones. They may, however, be of use as working standards for practical purposes and to enable a comparison to be drawn between effluents of varying degrees of purity. The successive dilution of tenths or decimal method of stating results which I have advocated greatly facilitates comparisons of this nature.

Procedure:—

Sewage and bad effluents.—To each of four sterilised 10 c.c. broth tubes† add severally by means of sterilised 1 c.c. pipettes, 1 c.c. from flasks (2), (3), (4), (5), representing respectively 0·01 ($\frac{1}{100}$; × results by 100) c.c.; 0·001 ($\frac{1}{1000}$; × results by 1,000) c.c.; 0·0001 ($\frac{1}{10000}$; × results by 10,000) c.c.; 0·00001 ($\frac{1}{100000}$; × results by 100,000) c.c. Incubate at 37° C., and on the fifth day test for indol by adding 1 c.c. of impure nitric acid (containing nitrites) to near the foot of each of the broth tubes. A purplish red colour indicates the presence of indol.

Example.—Tubes (2), (3), (4), corresponding to 1 c.c. of dilutions (2), (3), (4), gave a positive result as regards this indol test. Tube (5), corresponding to 1 c.c. of dilution (5), gave a negative result. Result, + ·0001 c.c. — ·00001 c.c. (at least 10,000 but not 100,000 indol-producing bacteria per c.c.).

In the case of good effluents use 1 c.c. of dilutions (1), (2), (3), (4), and as regards very good effluents 1 c.c. direct and 1 c.c. of dilutions (1), (2), (3), and inoculate broth tubes in the way above described.

6.—*Spores of B. enteritidis sporogenes* (Klein).

As I believe this test to be of singular value in the bacterioscopic examination of sewage and sewage effluents, it is necessary to enter somewhat fully into the chief reasons why I consider it of such importance.

Dealing first with some of the points which may be open to criticism, it is worthy of note that many bacteriologists consider that B. enteritidis sporogenes is not causally related to acute diarrhœa occurring in human beings. Avoiding controversial matters as far as possible, it may suffice to say that, in the opinion of Dr. Klein and Dr. Andrewes, the presumptive evidence in favour of its having been causally connected with certain epidemics of diarrhœa was of a strong kind, and to add that quite apart from this question, and other points possibly open to serious dispute the test, *as a test*, still remains in my judgment a most useful one. Again, the demonstration of B. enteritidis sporogenes in normal stools, as well as in the stools of patients suffering from acute diarrhœa, has been made much of. But diplococcus pneumoniæ, one of the most pathogenic microbes known, and believed to be the cause of croupous pneumonia, is not uncommonly present in the saliva of healthy individuals. A further point was raised, not in the first place by those hostile to the test, but by those whose practical experience had led them to adopt it, namely, that the spores of B. enteritidis could not be regarded as proof of *recent* animal pollution. This point was raised quite legitimately in connection with the bacteriological examination of soils and water supply.

* In a few drinking waters I have actually obtained a negative result when using for cultivation purposes the bacterial contents of 400 c.c. of the water.

† It is obvious that the primary broth cultures in connection with the B. coli test may be utilised for this purpose.

Subsequently the same argument was brought to bear, but without the same show of reason, on the question of sewage disposal. But sewage and sewage effluents *are* of recent animal origin and it needs no bacteriological test to demonstrate this fact. Lastly, milk cultures showing the enteritidis change are not always found to be virulent on injection into guinea-pigs, and there are other anærobic microbes which produce the same change, or a very similar one, under similar conditions of experiment. Whether the non-virulent character of some of these milk cultures is due to the presence of aberrant and non-pathogenic strains of the B. enteritidis or to microbes of separate species, is difficult to determine. But in my experience, if a substance in certain amount produces the enteritidis change in milk culture from which the whey is non-pathogenic to rodents, inoculation of milk cultures with a somewhat larger quantity of such substance produces whey which is pathogenic to rodents.

But whether B. enteritidis sporogenes is or is not causally related to diarrhœa, whether aberrant and non-pathogenic strains of B. enteritidis sporogenes or microbes producing a similar change in milk but of separate and harmless sort, can accompany and sometimes surpass in number the true B. enteritidis sporogenes, matters very little, so far as the test, *as a test*, is concerned; for in judging the value of a test we must look to the results obtained in actual practice. Now if the change in milk culture known as the "enteritidis change" is produced equally by pure as impure substances, for example, pure water as compared with sewage, non-polluted streams as compared with polluted rivers*, cultivated soils as contrasted with virgin soils, then indeed the test may be considered of small value. But what do we find as the result of very numerous experiments carried out during a period of several years?

Crude sewage usually gives a positive result with $\frac{1}{1000}$ c.c., and not uncommonly with $\frac{1}{10000}$ c.c.

Pure waters may yield a negative result even when the bacterial contents of as much as 100–500 c.c. of the water are used for cultivation purposes. (Compare Fig. 12, Plate VI., with Fig. 10, Plate VI.)

Cultivated soils, manured soils, and soils polluted with excremental matters, usually give a positive result with ·001 to ·0001 gramme.

Virgin soils usually yield a negative result with ·01 grm. and some with 1 gramme.

The "washings" of impure soils yield a positive result even when a minimal amount of the liquid is used.

The "washings" of pure soils either gives a wholly negative result or a positive result only when using relatively large quantities of the liquid.

These results, together with an extensive experience of the test in the course of the last four years, have consistently and conclusively proved that in actual practice the quantitative estimation of spores producing the "enteritidis change" in milk is one of the most valuable means we possess of determining the degree of biological purification arrived at in an effluent, as compared with the crude sewage from which it came. Moreover, as the B. enteritidis sporogenes test is carried out under anaerobic conditions, and thus gives a useful indication of the probable biological qualities of sewage and sewage effluents in relation to the number of spores of anaerobic bacteria of all sorts present in them, this reason alone justifies the employment of the test as a routine one, the more so since (apart from inoculation experiments) it is one of the simplest tests at present known.†

Procedure:—

The following method, except as regards the method of making the dilutions, is the one practised by Dr. Klein.

Four tubes, each containing 15 c.c. of sterilised milk are boiled for half an hour to expel the oxygen. They are then rapidly cooled by placing them in a large beaker containing cold water. Next they are inoculated severally with 1 c.c. of dilutions (1), (2), (3), (4), heated to 80° C.‡ for ten minutes, and placed in wide tubes containing a freshly-prepared mixture of pyrogallic acid and potassium hydrate solution. The wide tubes are then stoppered and placed in the hot incubator (37° C.).§ After 48 hours they are removed and examined for Klein's "enteritidis change." To test the virulence of the cultures showing the "enteritidis change" inoculate guinea-pigs subcutaneously with 1 c.c. of the whey. But if one is working with a large number of cultures and samples, it is, of course, unjustifiable to inoculate guinea-pigs on every occasion.

With bad sewage effluents proceed in the same way, but with good effluents use 1 c.c. direct of the liquid and 1 c.c. of dilutions (1), (2), (3).

A point worth noting is that in the great majority of cases if the samples are examined in the way I have recommended there is an absolute distinction between the positive and negative results, *i.e.* between the last tube (highest dilution) showing the "enteritidis change," and the one next it and higher in the scale of dilutions. Thus, to take an example, tubes (1), (2), (3), corresponding respectively to 1 c.c. of dilutions (1), (2), (3), show the "enteritidis change." Tubes (4), (5), corresponding to 1 c.c. of dilutions (4), (5), show absolutely no change at all. The

* It may be pointed out that a negative result as regards B. enteritidis sporogenes when using for cultural purposes a small quantity of a polluted river water does not prove that this anaerobe is altogether absent. Nor does it tend in any way to show that the test is not a valuable one. It is obvious, for example, that B. enteritidis sporogenes cannot reasonably be expected to be present in 0·1 c.c. of a polluted river water unless the contamination is gross in amount. But its absence from 0·1 c.c. in no way implies its absence from 1, 10 or 100 c.c.

† Perhaps I cannot put the matter more strongly than by saying that even if the milk cultures showing the "enteritidis change" were never virulent to animals, that even if the change in milk culture was never produced by bacteria in any way harmful to human beings or animals, I would still retain the test, AS A TEST, in the bacterioscopic examination of sewage, sewage effluents, soils and water supply.

‡ No elaborate apparatus is required for this purpose. A large beaker partially filled with water kept at a temperature of 80° C. will suffice. Or the simple form of apparatus (Figs. B, C, D. Plate IV.) used by Dr. Klein for many years, and which is reproduced here by his kind permission, may be employed.

§ Fig. F. Plate V.

distinction between tube (3), last positive, and tube (4), first negative, is definite and unmistakeable. No question of personal equation is involved, only one conclusion being possible in the great majority of cases to the inexperienced equally with the experienced workers.

Example.—Tubes (1), (2), (3), corresponding to 1 c.c. of dilutions (1), (2), (3), showed the "enteritidis change." Tube (4), corresponding to 1 c.c. of dilution (4), showed no such change. A guinea-pig inoculated with 1 c.c. of culture (3) died within 24 hours and showed the usual signs associated with B. enteritidis sporogenes ("floating belly," sanguineous exudation swarming with bacilli, etc.). Result + ·001; — ·0001 c.c. (at least 1000 but less than 10,000).

Figures 9, 10, 11, 12. Plate VI.

7.—*Streptococci.*

The streptococcus test is undoubtedly a difficult one, and is perhaps hardly to be recommended as a routine measure when the samples to be examined are very numerous. Its importance lies in the fact that it seems to yield certain information, not easily, if at all, to be obtained by the use of other and simpler tests.

I have advocated the use of this test in the bacterioscopic examination of soils, water supplies, and sewage effluents chiefly for the following reasons :—

Speaking of streptococci, *as a class*, it may be said that:

They are delicate germs and tend to soon lose their vitality and die.

They are present in abundance in the intestinal evacuations of animals.

They comprise species highly pathogenic to human beings.

They are present in sewage, sewage effluents, and *recently* polluted soils and water supplies, but are seemingly absent from relatively large amounts of virgin soils and pure waters, and may be absent (or relatively so) even from contaminated soils and waters when the contamination is not of *recent* animal outcome.

It is not disputed that there may be individual members of the streptococcus class which are comparatively hardy germs, and which may be able to exist and multiply under saprophytic conditions; but in judging the value of a test one must look very much to the results obtained in actual practice, and from this practical point of view the facts I have adduced can not I think be devoid of some significance.

There is great difficulty in distinguishing between streptococci of feeble vitality (of most significance) and those of more robust type (of less importance); but if an effluent contains streptococci in abundance and in approximately the same relative proportion to the total bacterial flora as the raw sewage before treatment, there would seem to be good ground for regarding such an effluent as potentially dangerous to health.

The B. coli test is one of great value, but B. coli is a more hardy germ than B. typhosus and the cholera vibrio. Although as a working hypothesis it is wise to regard the presence of B. coli in any number as an indication of the possible occasional presence as well of other intestinal microbes of more dangerous sort, it might be contended that a particular process of purifying sewage was capable of effecting the destruction of B. typhosus and the cholera vibrio, if present while yet failing to destroy the more hardy micro-organisms belonging to the B. coli class. The more delicate members of the streptococcus group are seemingly less hardy than the typhoid bacillus and the cholera vibrio, and therefore the demonstration of their presence in an effluent is of special significance. But to sift these sensitive members of the streptococcus group from their more hardy neighbours is no light task, and probably in practice it is sufficient to demonstrate the presence of streptococci in abundance in an effluent to draw conclusions of value. So far, then, as my experience goes, the presence of streptococci in an effluent in any number, or in the same proportion relative to the total bacterial flora as in the sewage before treatment, is a useful indication of the biological *status* of such an effluent in relation to the possible occasional presence as well of other intestinal microbes of more dangerous sort.

Some streptococci, be it noted, are causally connected with morbid processes occurring in the human subject, and a few of them are possessed of conspicuous disease-producing power. To separate these streptococci from others of comparatively harmless sort, in the case of sewage and effluents, if they were in reality present in them, would be a most difficult task. As a matter of fact, such of the sewage streptococci as I have tested have usually displayed little or no pathogenic power when subcutaneously injected into mice. This does not necessarily mean that they would be harmless to other animals, nor that they were derived from a harmless source, nor that they would be incapable, under certain conditions, of regaining their pathogenic properties if previously present. But it is wise to base the value of the test on general grounds, and while not discarding the possibility of the streptococci themselves being harmful to human beings, to look upon the test rather as a proof of the presence of intestinal and therefore undesirable microbes, and as an indication of the possible occasional presence as well of other and seemingly more hardy microbes of a sort definitely pathogenic to human beings, *e.g.*, the typhoid bacillus.

In conclusion, the streptococcus test would seem to be of special value, because the presence of streptococci in any number in an effluent tends to show, more so perhaps than any other test, that the sewage has not become so modified biologically by its treatment as to be other than a liquid still potentially dangerous to health. As regards standards, I think it would be unwise to make any definite statement in connection with this test.

Procedure :—

Pour four agar plates. After a suitable interval to allow the agar to set, inoculate in the case of crude sewage the plates severally with 0·1 c.c. of dilutions 1, 2, 3, 4. Bad effluents may be treated in the same way, but in the case of good effluents use 0·1 c.c. of the liquid direct and 0·1 c.c. of dilutions (1), (2), (3). In each case spread the liquid over the surface of the agar by means of a sterilised platinum "spreader." Invert the plates and incubate at 37° C. After

24–48 hours examine the plates with a strong hand lens and also under a low power of the microscope. Subculture the minute colonies resembling streptococci in broth tubes and incubate the broth culture at 37° C. After 24–48 hours examine the broth cultures and make stained (preferably by Gram's method) and unstained microscopic preparations from all those showing growth. From the broth tubes which on preliminary microscopic examination seem to contain microbes belonging to the streptococcus group, subcultures are made in various media, *e.g.*, litmus milk, gelatine (streak and plate cultures) and agar (streak and plate cultures), and the morphological and biological characters of the microbe carefully determined.

Example.—Four agar plates were severally inoculated with 0·1 c.c. of dilutions (1), (2), (3), (4). From the 0·1 c.c. of (2) dilution plate two microbes were isolated, which on further study were found to belong to the streptococcus group. No microbes of comparable sort were found in the 0·1 c.c. of (3) dilution plate. Result = at least 1,000 but less than 10,000 streptococci per c.c.

Figures 13, 14, 15, 16. Plate VII.

8.—*Number of Anaerobic Bacteria.*

I desire to repeat the views I have from time to time expressed, namely, that most of the strictly anaerobic microbes of importance in sewage are present in the form of spores; that the B. enteritidis sporogenes test is a spore-test carried out under anaerobic conditions; and that I have long since convinced myself by actual experiments that Klein's test is a most useful guide to the bacterial contents of sewage and effluents as regards the number of sporing anaerobes of all sorts present in them. By Klein's test I do not mean observation of the presence or absence of B. enteritidis sporogenes in 1 c.c.* of a sample, but its *relative abundance;* whether for example it is present in 1 c.c., 0·1 c.c., 0·01 c.c., 0·001 c.c., or 0·0001 c.c. of the sample.

In this indirect sense the Commission will receive anaerobic records dating from the commencement of my investigations.

9.—*Thermophilic Bacteria.*

10.—*H_2S. Bacteria.*

The estimation of thermophilic bacteria and H_2S. microbes is not altogether unimportant. The chief point of importance being to draw judicious and cautious inferences from the results obtained by the use of these tests. But the number of other and more valuable biological tests available seems to render their employment hardly necessary and so they will not be further considered.

11.—*Inoculation of Animals.*

(either directly with sewage and effluents, or with pure cultures of microbes derived from these liquids).

In special cases the inoculation of animals is most important, as has been clearly shewn by the results of the Yeovil experiments. But as a routine test it can hardly be recommended. This subject has been already dealt with in two separate reports (Yeovil report, and the subcutaneous inoculation of animals report) and so need not here be further discussed.

Section II.—Simple bacteriological tests and suggested standards.

The Commission has already received a report from me on this subject, and therefore it will be unnecessary to enter into full details.† The simple tests then recommended were as follows:—

12.—" *Gas* " *test.*

" Gas " in gelatine " shake " cultures [24 hours at 20° C.].

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* As regards sewage the use of 1 c.c. or even 0·1 c.c. for cultural purposes is of small value, since in the great majority of cases a positive result is obtained with ·01 to ·001 c.c. Even in the case of effluents a majority would be likely to show the " enteritidis change " with ·01 c.c.

Conversely the absence of B. enteritidis sporogenes from 0·1 or even 1 c.c. of a polluted river water in no way implies its absence from a larger quantity or tends to lessen the intrinsic value of the test. To be present in this amount would probably mean a pollution so gross in character as to be apparent to the senses.

† Preliminary report on simple bacteriological tests. It may not be amiss to repeat certain of the conclusions given in the report, namely, as follows:—

" None of these simple tests (or any other of similar sort that I am acquainted with) are to be regarded as other than ready methods of judging the probable biological qualities of sewage effluents and their degree of purification.

" No tests of the above kind can ever adequately replace the more laborious but much more reliable methods which have prevailed in the past. For example, plate cultivations and the subsequent attentive study of the resulting colonies and the behaviour of subcultures of these colonies when grown in various media.

" In brief, these handy, rough and ready tests, useful as they undoubtedly are, should be relied on as indicating the probable, rather than of necessity the actual truth."

13.—*Litmus milk test.*

Acid clotting of litmus milk cultures [24 (? 48) hours at 37° C.].

14.—*Neutral red broth test.*

Greenish-yellow fluorescence in neutral red broth cultures [24 (? 48) hours at 37° C.].

To these must be added, as already indicated, and described at page 8 of this report:—

Indol test. [5.—page 8.]

Indol in broth cultures [5 *days at* 37° *C.*]

B. enteritidis sporogenes test. [6.—page 8.]

Klein's "enteridis change" in anaerobic milk cultures [48 *hours at* 37° *C.*]

Apart from the inoculation of animals this test is an extremely simple one. A point worth noting is that the proposed standard (for non-drinking water streams) involves no troublesome dilutions. A positive result with $\frac{1}{10}$ *c.c.* (0·1 *c.c., about two drops) would so far as this particular test is concerned condemn an effluent. It has already been considered in this report.*

Athough the litmus-milk test yields useful results, I think it might with advantage be incorporated with MacConkey's test in the way presently to be described.

I deal now in detail with those "Simple Bacteriological Tests" which have not hitherto been described.

"*Gas*" *test.* (No. 12.)

"*Gas*" *in gelatine* "*shake*" *cultures* (24 *hours at* 20° *C.*).*

In regard of this test the following points are worthy of note:—

1. There is a broad parallelism between the results obtained by the use of the "gas" test and (*a*) the general chemical results, and (*b*) the general bacteriological results.

2. In sewage the number of gas-forming bacteria is remarkable, both actually and in relation to the total bacterial flora.

3. Most of these "gas-forming" bacteria belong to the objectionable B. coli and B. proteus class. Not uncommonly these gas-forming proteus-like microbes are found to be pathogenic in the case of rodents.

4. There is a broad parallelism between the number of these microbes in sewage and sewage effluents and the amount of such liquid required to produce a visible development of "gas" in gelatine "shake" culture.

5. In pure waters "gas-forming" bacteria are relatively absent. When present their ratio to total number is apt to be much less than in the case of sewage and sewage effluents. In many cases I have failed to get a positive result, even when using for cultivation purposes the bacterial contents of 100 c.c. (Pasteur "filter-brushing" method).

6. The "gas" test is not nearly so delicate as some other methods for the numerical estimation of B. coli and B. proteus, because a certain number of these gas-forming microbes are necessary to produce a visible development of gas in gelatine "shake" cultures within a reasonable time. The excessive delicacy of these other tests is, however, in some respects, a positive disadvantage when dealing with grossly impure liquids of the nature of sewage and most sewage effluents.

7. Side by side with the destruction of oxidisable and putrescible matter there is usually a corresponding reduction in the number of gas-forming bacteria. This, however, is more apparent in the case of land than as regards bacteria-bed processes of sewage treatment.

8. Observation of the number of "gas-forming" bacteria in a liquid is an indirect method of gauging its probable degree of putrescibility.

9. To some extent the number of gas-forming bacteria is an index of the potential harmfulness of an effluent.

10. The test is one of easy application, and the proposed standard (for non-drinking water streams) involves no troublesome dilutions.† A positive result with $\frac{1}{10}$ c.c. (0·1 c.c., about 2 drops) would condemn an effluent.

Procedure.—In the case of strong sewage and very bad effluents add severally to four 10 c.c gelatine tubes 1 c.c. of dilutions (2), (3), (4), (5). Place the tubes in warm water (about 40° C.) for a few minutes to melt the gelatine. Shake the tubes so as thoroughly to mix their contents,

* The test may be rendered more delicate by extending the time from 24 to 48 hours, but for various reasons this is not recommended. Indeed, it was the wish of the Commission that some simple biological test should be adopted which in relation to its own particular standard involved no troublesome dilutions, and the extension of the time limit would necessitate the use of dilution methods. It is obvious that this test might be modified in a number of ways. For example, glucose might be added to the gelatine, or perhaps litmus or neutral red. Further agar, might be employed instead of gelatine, and use might be made of litmus, neutral red or glucose, and the cultures incubated at 37° C. instead of 20° C. *By adopting a temperature of* 20° C. *those gas-forming microbes are included which refuse to grow at blood-heat.*

† This is a point upon which the Commission laid special stress. The question was repeatedly asked. Is any biological test known which can be applied by a comparatively unskilled worker to the examination of sewage effluents without resort being had to the troublesome method of dilution? The answer is that both the B. enteritidis sporogenes and "gas" tests, according to my provisional standards, are to be regarded in this light. In each case an effluent is "passed," even if it gives a positive result with 1 c.c. (about 20 drops), provided it gives a negative result with 0·1 c.c. (about 2 drops).

and then place them in cold water until the gelatine has become solid again. Incubate at 20° C. and after 24 hours examine them for "gas" production. In the case of fairly satisfactory effluents and some samples of sewage, use 1 c.c. of dilutions (1), (2), (3), (4), and with good effluents 1 c.c. of the liquid direct and 1 c.c. of dilutions (1), (2), (3).

Example: Four gelatine tubes were severally inoculated with 1 c.c. of dilutions (2), (3), (4), (5). After 24 hours' incubation at 20° C. (2) and (3), but not tubes (4) or (5) showed gas formation. Result = + ·001 c.c. ($\frac{1}{1000}$ c.c.); — ·0001 c.c. ($\frac{1}{10000}$ c.c.).

See Figs. 17, 18, 19, 20. Plate VIII.

Litmus milk test. (No. 13.)

Acid clotting of litmus milk cultures (24 [? 48] *hours at* 37° *C.*).

Although perhaps this test might be abandoned in favour of the other tests that I have mentioned, a brief description of it may not be out of place.

A conspicuous property of B. coli (and allied forms) is the production of strong acid and clotting in milk cultures. It is true that other micro-organisms possess these attributes, but they are apt to be present in smaller proportion than B. coli in sewage and sewage effluents. If, therefore, the *smallest amount* of sewage or effluent capable of producing acid clotting in milk cultures be determined, the inference is that the change in the milk has been effected by the growth of B. coli or closely allied forms. However this may be, it is a fact worth noting that whereas $\frac{1}{10000}$ to $\frac{1}{100000}$ c.c. of crude sewage commonly produces acid clotting of milk in 24 hours at 37° C., 1 c.c. or more of, at all events some pure water, fails to effect a similar result. The test may be rendered more delicate by lengthening the period of observations from 24 hours to 48 hours, or by taking note of acidity independently of clotting.

Procedure—Add severally in the case of crude sewage and bad effluents to four tubes, each containing 10 c.c. of sterile milk tinted with litmus solution, 1 c.c. of dilutions (2), (3), (4), (5). Incubate the tubes at 37° C. for 24 hours, and note the result as regards acidity and clotting of milk. In the case of fairly satisfactory effluents use 1 c.c. of dilutions (1), (2), (3), (4), and as regards good effluents, 1 c.c. of the liquid direct and 1 c.c. of dilutions (1), (2), (3).

Example: Tubes (2), (3) (corresponding to 1 c.c. of solutions (2), (3)), showed acidity and clotting, and tube (4), (corresponding to 1 c.c. of dilution (4), acidity but no clot. Tube (5) (corresponding to 1 c.c. of dilution (5), showed no visible change. Result, as regards acidity and clotting = + ·001 ; — ·0001 c.c. As regards acidity only + ·0001 ; — ·00001 c.c.

Neutral red broth test. (No. 14.)

Greenish-yellow fluorescence in neutral red broth cultures [24 (?48) * *hours at* 37° *C.*].

Rothberger first drew attention to the value of agar tinted with neutral red solution as a means of distinguishing B. coli and B. typhosus. The former microbe gives rise to a highly characteristic change in the medium, namely, greenish-yellow fluorescence, whereas the latter micro-organism leaves the crimson-tinted agar unaltered in colour.

In 1900 Dr. Klein drew my attention to the possible value of neutral red tinted media in connection with my work. Since then I have been studying—although in a different sense to that suggested by Rothberger—the value of the test on behalf of the Commission. It was found that by using broth† instead of agar, and in the way about to be described, the test could be applied with success to the examination of crude sewage and sewage effluents for B. coli (and closely allied forms). Recently Hunter, Savage and others have shown that the test is a most useful one in the bacteriological examination of water. The test is *not specific*, and so must be regarded as of relative and not absolute value. Nevertheless, in the case of sewage and sewage effluents those microbes which, as well as the classical B. coli, change the crimson-tinted broth to a fluorescent greenish-yellow colour, are either closely akin to B. coli (and so must be regarded as allied forms), or else are micro-organisms far less numerous in sewage and sewage effluents than B. coli (and therefore may perhaps reasonably be ignored). In short, in the case of sewage and effluents the number of B. coli present may be measured with relative if not absolute certainty by noting the *smallest amount* of the liquid capable of changing the crimson tint of neutral red broth to a greenish-yellow fluorescent colour. The experiments that have now been made by way of comparing the results obtained by the use of this test, with the record as regards B. coli, are now very numerous. There can be no question that in the majority of instances, and in the case of sewage and sewage effluents, the results are in close agreement. Indeed, it may be said that the curves obtained by the use respectively of the neutral red broth, litmus milk, B. coli and indol tests show a decided parallelism in the majority of cases. The gas and B. enteritidis tests run, if I may so term it, at a lower level, but show a broad parallelism with each other and also with the above tests.

In the case of the discharge of effluents into non-drinking water streams the standard suggested is that an effluent should be "passed" even if it gives a positive result with $\frac{1}{100}$ c.c., provided it gives a negative result with $\frac{1}{1000}$ c.c.

Procedure.—Four tubes each containing 10 c.c. of sterile broth tinted with neutral red solution are severally inoculated as follows:—

In the case of crude sewage and bad effluents use 1 c.c. of dilutions (2), (3), (4), (5). With fairly satisfactory effluents 1 c.c. of dilutions (1), (2), (3), (4), may be employed. As regards good effluents it is advisable to work with 1 c.c. of the liquid direct and 1 c.c. of dilutions (1), (2), (3). The tubes are incubated at 37° C., and the result noted after 24 (? 48) hours as regards production of a fluorescent yellowish green colour (positive result).

* The test may be rendered more delicate by extending the time limit to 48 hours.

† Ordinary broth (not glucose broth) in my experience yields the best results, but the broth I use always contains traces of sugar. About 2 to 3 c.c. of a 1 per cent. solution of neutral red in 1,000 c.c. broth gives a useful tint of red.

Example:—Tubes (2) (3) (4) (corresponding to 1 c.c. of dilutions (2) (3) (4)) showed greenish-yellow fluorescence. Tube (5) (corresponding to 1 c.c. of dilution (5)) showed no such change of colour. Result + ·0001 c.c. – ·00001 c.c. (at least 10,000, but less than 100,000 microbes capable of reducing neutral red broth per c c.).

Bile-salt broth test. (No. 15.)

Dr. MacConkey has suggested the use of a medium for bacteriological purposes having the following composition:—

Sodium Taurocholate	0·5 per cent.
Glucose	0·5 ,,
Peptone	2·0 ,,
Water	100 c.c.

The constituents are heated together, filtered and tinted with litmus solution. The medium is then poured into test tubes and a fermentation tube placed in each. The tubes are next sterilised in the usual way.

The use of peptone, glucose and litmus, is of course, not new, but the addition of sodium taurocholate as an inhibitory agent is quite novel. The litmus is used as an index of acid formation just as in the litmus milk test. As regards gas formation this may be observed in ordinary broth cultures, but no doubt the addition of glucose and the use of an inner fermentation tube makes it much more pronounced.

The bile broth test was originally stated, although not by Dr. MacConkey, to be a specific test for B. coli. Later, Dr. MacConkey and Dr. Hill describe it as a *simple test for faecal contamination*, and in this modified sense the test is likely to prove a most useful one.

The authors say (Thomson Yates Laboratories' report Vol. IV. Part I.):—

"*It is, therefore, justifiable to conclude, that when the reaction is obtained, it is most probably produced by organisms of intestinal origin.*"

"*Conversely it may be stated, that when the reaction is not present, faecal contamination is absent.*"

The former statement is a moderate one and appears to be quite reasonable, the latter is open to criticism.

How far this is true may be judged by the results of the following simple experiment:—one-third gramme of faeces was mixed with 10 c.c. of sterile water. 1 c.c. of the mixture was used to inoculate (*a*) a bile-salt broth tube and (*b*) a milk tube. Both tubes were heated to 80° C. for 10 minutes and (*b*) tube was further cultivated under anaerobic conditions.

In (*a*) tube no growth occurred and therefore according to the author's statement faecal contamination was absent.

In (*b*) tube the typical "enteritidis change" occurred and 1 c.c. of the culture injected subcutaneously into a guinea-pig, killed the animal in less than 24 hours.

But what the authors probably mean is this:—Conversely it may be stated, that when the reaction is not present the absence of *recent* and *therefore specially objectionable contamination* may be inferred. Or, to put it in a slightly different way: conversely it may be stated that when the reaction is not present the probable absence of intestinal bacteria, *other than those present as spores*, may reasonably be inferred.

In using this test three observations have to be made, namely:—

Presence or absence of growth.*
,, ,, acidity (reddening of the litmus).
,, ,, gas formation (bubbling of liquid and rise of inner fermentation tube).†

B. coli gives a markedly positive result as regards growth, acidity and gas formation, and the great majority of the other microbes that were tested gave a negative result in one or all of these respects.‡ There is a class of microbes to be found in sewage and other substances which resemble B. coli in many respects, but which slowly liquify gelatine. Some at all events of the members of this group give a positive result with the bile-salt broth test. According to many authorities this property of liquefaction prevents their inclusion in the coli group. But even if this view be accepted it is not unlikely that they, like B. coli, are microbes of intestinal origin. About seventeen micro-organisms§ according to Dr. MacConkey and Dr. Hill do indeed yield completely positive results with this test, but they regard this fact as of minor importance, since practically all of the microbes are believed by them to be of intestinal origin and therefore objectionable. No one is likely to cavil at this moderate statement, and it remains to be added that these workers deserve great praise for the excellent quality and great quantity of work carried out by them in connection with this new and valuable test. In its *negative* aspects, and assuming that the microbes which do not respond to the test are either of secondary importance or that they would in practice be always accompanied by the microbes which do not yield a positive result, the test is certainly an extremely useful one. In its *positive* aspects the test may be judged to be far too comprehensive, yet in opposition to this it may be asked what other *simple* test is available which is so differential in character in relation to the detection of the presence of non-sporing microbes of intestinal sort.

* I have experienced some little difficulty in this respect, as I have failed to prepare the medium free from a certain muddiness which simulates to a slight, but not material extent, bacterial growth.

† The rising of the small inner tube does not always occur in my experience, but the bubbling of the liquid is very striking.

‡ That is in pure culture, whether these or other bacteria acting in conjunction (symbiosis) could effect a positive result is not definitely known, but may be considered improbable.

§ Among these is B. acidi lactici (Hueppe) which is described in the text-books as a sporing micro-organism. But there seem to be grounds for doubting whether a sporing form in reality exists, and in any case there is every reason to believe that the lactic acid bacillus referred to by the authors is a non-sporing microbe. Since writing this report, Dr. MacConkey sent me a culture of B. acidi lactici. An agar culture incubated at 37° C for four days was killed by heating to 80° C. for 10 minutes, so presumably there was no spore formation.

The authors do not seem to have tried the following simple experiment:—

If sewage, manured soil, or milk be first heated at 80° C. for 10 minutes (to kill all the microbes not present as spores), relatively large quantities of these materials may subsequently be added to bile-salt broth without effecting a positive result as regards acidity and gas production. That is to say a *mixture of the spores of bacteria of diverse sort* added to this medium does not give rise to a positive result. As it seems to me this fact alone is a strong indication of the probable value of the test as a means of detecting recent contamination when considered in relation to the positive results induced by the addition of the same substances in minimal amounts to bile-salt broth in the unheated condition. There may be exceptions to this rule, but so far I have not observed them.

There is one circumstance in connection with this test when compared with the old carbol agar method which is not quite clear. Miss Chick working with carbol agar found B. coli to be present in 1 c.c. in only 17 out of 239 samples of new milk (*seven per cent.*), Drs. MacConkey and Hill using bile-salt broth obtained a reaction (due to B. coli) in no less than 98 out of 103 samples of milk (*ninety-five per cent.*). The disparity of results is striking, but doubtless many circumstances of a convincing nature might be advanced in explanation.

Latterly, none of the criticisms that have been offered must be interpreted as attempts to minimise the practical value of the test in the bacteriological examinations of sewage and effluents, but rather as an endeavour to enhance its ultimate usefulness by correcting or modifying certain inferences which in the present state of our knowledge may be considered not wholly reliable.

Litmus milk (*bile-salt broth*) *test.* (No. 16.)

It occurred to me that it might be possible to combine the litmus milk test which takes note of acid clotting of the medium with Dr. MacConkey's bile-salt method, which aims at inhibiting the growth of non-intestinal bacteria and takes note not only of acidity but of gas formation as well. Such a combined method would take note of four things:—

Presence or absence of any visible change in the medium.* Acidity (this might be more easily observed in litmus milk, owing to its opacity, than in litmus tinted bile-salt broth which although meant to be transparent is apt to have a muddy appearance.

Gas formation.†

Clotting (this would introduce the fourth factor, and one I think of considerable importance).‡

It need not be added that even if this combined method was found to be of advantage the test ought still to be regarded as primarily Dr. MacConkey's.

The medium is easily prepared: To 200 c.c. of milk diluted with 800 c.c. of distilled water, tinted with litmus solution and rendered faintly alkaline, are added the following ingredients, viz., 10 grammes (1·0 per cent.) lactose, 5 grammes, (0·5 per cent.) sodium taurocholate and 20 grammes (2·0 per cent.) peptone. The mixture is heated to dissolve these materials, then 10 to 12 c.c. are poured into each of a number of test tubes (6 in. × $\frac{3}{4}$ in.) and a small test tube (2 in. × $\frac{1}{2}$ in.) added to each tube. It is perhaps a better plan to dissolve the ingredients in the 800 c.c. of water, filter, and then add the filtrate to the milk.

Sterilisation is effected by heating in the steam steriliser for half an hour on three successive days.

Whether the litmus milk bile-salt broth test or the bile-salt broth is employed, the procedure is the same, namely, as follows:—

Procedure.—Four tubes each containing 10 to 12 c.c. of the medium are severally inoculated as follows:—

In the case of crude sewage and bad effluents with 1 c.c. of dilutions (2), (3), (4), (5). With fairly satisfactory effluents 1 c.c. of dilutions (1), (2), (3), (4), may be employed. As regards good effluents it is advisable to work with 1 c.c. of the liquid direct and 1 c.c. of dilutions (1), (2), (3). The tubes are incubated at 37° C. and the result noted after 24 to 48 hours, as regards acidity and gas formation and in the case of the litmus milk, as regards clotting as well.

Example:—Tubes (2), (3), (4), corresponding to 1 c.c. of dilutions (2), (3), (4) showed acidity, gas formation and clotting. Tube (5), corresponding to 1 c.c. of dilution (5) gave a negative result. Result + ·0001 c.c. — ·00001 c.c. (at least 10,000 but less than 100,000 microbes capable of giving rise to acid clotting of milk, and to gas formation per c.c.).

The standard suggested is the same whether the modified litmus milk or the simple bile-salt broth test be used. viz., that an effluent should be passed, even if it gives a positive result with ·01 c.c., provided it gives a negative result with ·001 c.c.

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* The taurocholate of soda does not seem, however, to have the same inhibitory action in this medium as in Dr. MacConkey's broth. And it is possible that very similar results might be obtained without the addition of the peptone and taurocholate of soda. The addition of sugar is certainly of value, but lactose should be used in place of glucose.

† Instead of a small fermentation tube in a relatively large test tube I think it better to use a 2 in. × $\frac{1}{2}$ in. test tube in a 6 in. × $\frac{3}{4}$ in. test tube. After sterilization the inner tube is all but completely filled with the medium, and projects some distance above the level of the liquid in the outer tube. After inoculation (say, with B. coli) the gas formed collects at the top of the inner tube and the liquid is partially displaced, thus leading to a rise of level of the medium in the outer tube.

‡ Taken in conjunction with the indol and neutral red broth tests, this means information regarding all the important positive qualities of the coli tribe, namely, gas formation, acidity, clotting of milk, indol formation and reduction of neutral red.

Section III.—Summary and Conclusions.

This report necessarily contains such an accumulation of facts and so bewildering a mass of detail that it is advisable to summarise briefly the main points that have been considered.

Relative abundance of microbes of different species in sewage and effluents.

The determination of the relative abundance of certain microbes of intestinal origin in sewage and effluents, and not of their mere presence or absence from a given quantity of these liquids, has formed the basis of past work for the Commission. This purpose is best achieved by successive dilutions of tenths, or the decimal method of making dilutions and recording results. Much still remains to be done in this connection, but so far as the *particular* tests chosen for routine work are concerned the records date back to the commencement of my work for the Commission.

Relative value of the different tests employed.

This is a matter which is necessarily a debatable one; but, speaking from my own experience I have no hesitation in placing in the front rank an aerobic and an anaerobic test—namely, (1) B. coli and (2) B. enteritidis sporogenes. As regards the former (B. coli test), it may again be pointed out that no test based on observation of a change or changes produced in the nutrient medium and supposed to be characteristic of B. coli can compare with isolation in plate cultivations of the microbes suspected of being B. coli, and the subsequent attentive study of the biological characters of pure cultures in various media of these bacteria. For the estimation of B. coli the primary broth and secondary gelatine plate culture method is to be preferred, the more so since the primary broth cultures may subsequently be utilised for the important indol test. As regards the second test, namely, the B. enteritidis sporogenes test, the question of the inoculation of animals is the only objection, and this, perhaps, need only be resorted to when we are dealing with sewage and effluents of abnormal sort, and hence with substances regarding which there may possibly be grounds for doubting whether the "enteritidis change" in the milk culture is necessarily an indication of its pathogenicity. But in any case observation of the "enteritidis change" alone in milk cultivations is of great value as a test of the probable biological qualities of sewage and effluents as regards the relative abundance of spores of anaerobic bacteria of all sorts present in them.

(A) The streptococcus test is in some respects more important than either of the foregoing, but it is too difficult a test to be employed as a routine one, when a multiplicity of samples have to be examined. It may therefore be placed in a separate category.

(B) Similarily the inoculation of animals' test, although capable under special circumstances of yielding results of signal value, can hardly be recommended in routine work.

The following *simple* tests are more or less differential in character, and are all of considerable value in routine work:—Bile-salt broth test, neutral red broth test, litmus milk (modified) test, indol test (above referred to), "gas" test.

A comprehensive and useful test, if the results obtained are interpreted in a judicious manner, is estimation of the total number of bacteria in gelatine at 20° C. and in agar at 37° C.

Of tests, probably of subsidiary importance, unless in special cases, the following may be mentioned:—Liquefying bacteria, spores of aerobic bacteria, thermophilic bacteria, H_2S bacteria.

The above facts and inferences may be presented in tabular form as follows:—

Most important tests.	Special tests of great value in certain cases.
1. B. coli test.	A. Streptococcus test.
2. B. enteritidis sporogenes test.	B. Inoculation of animals test.

Simple, more or less differential, tests of considerable value in routine work.

(*a*) Bile salt broth test (enumeration of faecal microbes of non-sporing sort, *e.g.*, B. coli).	(*a*) Neutral red broth test. (*b*) Litmus milk (modified) test. (The number of B. coli may be measured with relative certainty by noting the *smallest* amount of the liquid yielding a positive result with each of these two tests.)	1. "Gas" test (gelatine "shake" cultures). (Gas-forming bacteria of all kinds, but chiefly those belonging to the objectionable B. coli and B. proteus class.) 2. Indol test. (Indol-producing bacteria, *e.g.*, B. coli.)

A generally useful test, if the results obtained are interpreted in a judicious manner:—

3. Total number of bacteria.
Gelatine at 20° C.
Agar at 37° C.

Tests, probably of subsidiary importance, unless in special cases :—

4. Liquefying bacteria.
5. Spores of aerobic bacteria.
6. Thermophilic bacteria.
7. H_2S bacteria.

Provisional Standards (non-drinking water streams)

It must be distinctly understood that the standards suggested are provisional ones. They may, however, be of use as working standards for practical purposes, and to enable a comparison to be drawn between effluents of varying degrees of purity. They may be summarised very briefly as follows :—

Total number of bacteria—

Gelatine at 20° C less than 100,000 per c.c.
Agar at 37° C less than 10,000 per c.c.

B coli less than 1,000 per c.c.

B. enteritidis sporogenes / "Gas" test - - - } negative results 0·1 c.c.

Indol test - - - - / Neutral red broth test - / Bile-salt broth test - - / Litmus milk (modified) test } negative result 0·001 c.c.

C.—Table showing the successive dilutions of tenths or decimal method of recording results, together with certain bacteriological standards of a provisional kind.

The above is dealt with in the table accompanying the Report :—

D.—Description of micro-photographs and illustrations accompanying the Report.

Fig. A. Plate I. Drawing illustrating the "successive dilutions of tenths or decimal method" of making dilutions for bacteriological purposes. 1 c.c. of dilutions (1), (2), (3), (4), (5) represents respectively $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, $\frac{1}{10000}$ and $\frac{1}{100000}$ c.c. of the original sample.

[About half original size.]

Fig. 1. Plate II. shows the number of bacteria in 1 c.c. of (5) dilution ($\frac{1}{100000}$ c.c.) Rugby settled sewage sample 224. The sample contained 7,300,000 microbes per c.c. (gelatine at 20° C.).

[About natural size.]

Fig. 2. Plate II. shows the number of bacteria in 1 c.c. of (3) dilution ($\frac{1}{1000}$ c.c.) Rugby settled sewage, sample 224. The sample contained 820,000 microbes per c.c. (agar at 37° C.).

[About natural size.]

Fig. 3. Plate II. shows the number of bacteria in 1 c.c. of (4) dilution ($\frac{1}{10000}$ c.c.) Nottingham sewage, sample 329. This sample contained 4,040,000 microbes per c.c. (agar at 37° C.)

[About natural size.]

Fig. 4. Plate II. shows the number of bacteria in 1 c.c. of (2) dilution ($\frac{1}{100}$ c.c.) Nottingham land effluent, sample 332. This sample contained 4,700 microbes per c.c. (agar at 37° C.). The remarkable reduction in the number of bacteria in this sample as compared with the crude sewage (Fig. 3) is noteworthy.

[About natural size.]

Fig. 5. Plate III. illustrates the surface gelatine plate method for B. coli. The material used for inoculation purposes was 0·1 c.c. of (3) dilution ($\frac{1}{10000}$ c.c.) Rugby settled sewage, sample 224. The large filmy colony near the centre of the plate gave when subcultured the following result :—

Microscopically—Small actively motile rods, occurring singly in couples and as short chains.

Biological characters—(*a*) "gas" in gelatine shake culture in 24 hours at 20° C.
(*b*) uniform turbidity in broth cultures in 24 hours at 37° C., and
(*c*) positive result with the indol test (5th day).
(*d*) Acid clot in litmus milk cultures before the 5th day at 37° C.

[About natural size.]

Fig. 6. Plate III. also illustrates the primary broth and subsequent surface gelatine plating methods for B. coli. The plate was made from the broth tube containing 1 c.c. of (5) dilution ($\frac{1}{100000}$ c.c.) Rugby settled sewage, sample 224. One of the colonies subcultured yielded results exactly similar to those described under Fig. 5.

[About natural size.]

Fig. 7. Plate III. also illustrates the primary broth and subsequent surface gelatine plating method for B. coli. The plate was made from the broth tube containing 1 c.c. of (4) dilution ($\frac{1}{10000}$ c.c.) Rugby crude sewage, sample 233. One of the colonies subcultured yielded results exactly similar to those described under Fig. 5.

[About natural size.]

Fig. 8. Plate III. also illustrates the primary broth and subsequent surface gelatine plating method for B. coli. The plate was made from the broth tube containing 1 c.c. of (5) dilution ($\frac{1}{100000}$ c.c.) Rugby crude sewage, sample 235. One of the colonies subcultured yielded results exactly similar to those described under Fig. 5.

[About natural size.]

Figs. B. C. D. Plate IV. illustrates the simple apparatus used by Dr. Klein in connection with the B. enteritidis sporogenes test.

[Reduced about eight times.]

Fig. E. Plate V. shows the form of platinum spreader used by Dr. Klein.

[About natural size.]

Fig. F. Plate V. shows two milk tubes (previously inoculated and heated to 80° C.) contained in a wider-stoppered tube containing a mixture of pyrogallic acid and potassium hydrate solution ready for incubation at 37° C. for the B. enteritidis sporogenes test.

[About natural size.]

Fig. 9. Plate VI. Anaerobic milk cultures showing Klein's B. enteritidis change. The left tube represents $\frac{1}{10}$ and the middle tube $\frac{1}{100}$ c.c. (1 c.c. of dilutions (1) and (2) of Aldershot settled sewage (sample 86)). The right tube represents 1 c.c. of dilution (2) ($\frac{1}{100}$ c.c.) of Aldershot final land effluent (sample 87)).

[About natural size.]

Fig. 10. Plate VI.: Anaerobic milk cultures showing Klein's B. enteritidis change. From left to right the tube represents $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, and $\frac{1}{10000}$ c.c. (1 c.c. of dilutions (1), (2), (3), (4) of Nottingham crude sewage (sample 329). This result reads + ·001 ; – ·0001 c.c., at least 1,000, but less than 10,000 spores of B. enteritidis sporogenes per c.c. The abrupt distinction between the last tube on the right (negative result $\frac{1}{10000}$ c.c.) and the one next it on the left (positive result $\frac{1}{1000}$ c.c.) is worth noting. The figure illustrates very clearly the results usually obtained in the case of crude sewage when using this test.

[About natural size.]

Fig. 11. Plate VI. ; Anaerobic milk cultures showing Klein's B. enteritidis change. From left to right the tubes represent $\frac{1}{100}$ c.c. (1 c.c. of dilution (2)), Nottingham crude sewage sample 334); and 1 c.c. direct respectively of samples 333, 335, and 336, Nottingham land effluents. The positive result with $\frac{1}{100}$ c.c. of the crude sewage and the absolutely negative results with the 1 c.c. direct of the three samples of effluent is striking. It will be remembered that my provisional standard "passes" are effluent giving a positive result with 1 c.c. provided it gives a negative result with 0·1 c.c. It is obvious that these three samples of effluent easily passed the suggested standard.

[About natural size.]

Fig. 12. Plate VI.: Anaerobic milk cultures as for B. enteritidis sporogenes, showing as regards certain well waters a totally negative result. From left to right the two first tubes represent respectively the bacterial contents of 100 and 200 c.c.. The third and fourth tubes represent respectively the bacterial contents of 100 and 200 c.c. of another well water. Compare these results (negative result 200 c.c.) with Fig. 10 (positive result $\frac{1}{1000}$ c.c., third tube from left to right).

Fig. 13. Plate VII. Streptococcus 24, isolated from 0·1 of (2) dilution ($\frac{1}{1000}$ c.c.) surface agar plate culture of a sample of Exeter septic tank effluent (March 26th, 1901). Microscopic preparation from a broth culture (two days at 37° C.). Stained with carbol-fuchsin.

[Magnifying power 500.]

Fig. 14. Plate VII. Streptococcus 14 isolated from 0·01 of (2) dilution ($\frac{1}{10000}$ c.c.) surface agar plate culture of Beddington land effluent, sample 150. Microscopic preparation from a broth culture, stained by Gram's method.

[Magnifying power 500.]

Fig. 15. Plate VII. Streptococcus 1 isolated from 0·01 of (2) dilution ($\frac{1}{10000}$ c.c.) surface agar plate culture of Nottingham crude sewage, sample 10. Microscopic preparation from a broth culture, stained by Gram's method.

[Magnifying power, 1,000.]

Fig. 16. Plate VII. Strepococcus 4 isolated from 0·01 of (1) dilution ($\frac{1}{1000}$ c.c.) surface agar culture of South Norwood crude sewage, sample 21. Microscopic preparation from a broth culture stained by Gram s method.

[Magnifying power, 1,000.]

Fig. 17. Plate VIII. illustrates the results obtained by using the "gas" test ("gas" in gelatine "shake" cultures in 24 hours at 20° C.). From left to right the tubes represent $\frac{1}{100}$, $\frac{1}{1000}$, $\frac{1}{10000}$ and $\frac{1}{100000}$ c.c. 1 c.c. of dilutions (2), (3), (4), (5) of Nottingham crude sewage, sample 334. It will be noticed that there is distinct gas formation in the first three tubes, whilst in the fourth tube, although there is growth, no gas bubbles can be seen. The result thus reads + ·0001 c.c. — ·00001cc.

[About natural size.]

Fig. 18. Plate VIII., also illustrates the results obtained by using the "gas" test ("gas" in gelatine "shake" cultures in 24 hours at 20° C.). From left to right the tubes represent $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$ c.c., 1 c.c. of dilution (1), (2), (3) of Cambridge settled sewage, sample 91. It will be noticed that all three tubes show a positive result.

[About natural size.]

Fig. 19. Plate VIII., also illustrates the results obtained by using the "gas" test ("gas" in gelatine "shake" cultures in 24 hours at 20° C.). From left to right the tubes represent 1 c.c. direct respectively of samples 333, 335 and 336 Nottingham land effluents. It will be observed that although in each case there is growth the result is quite negative as regards "gas" production. As the standard suggested is that an effluent should be "passed" even if it gives a positive result with 1 c.c., provided it gives a negative result with 0·1 c.c. it is clear that these three samples of effluent easily passed the suggested standard.

Fig. 20, Plate VIII., also illustrates the results obtained by using the "gas" test ("gas" in gelatine "shake" cultures in 24 hours at 20° C.). From left to right the tubes represent $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$ and $\frac{1}{10000}$ c.c., 1 c.c. of dilutions (1), (2), (3), (4), Aldershot settled sewage, sample 86. Note that the first three tubes yield a positive result as regards "gas" formation, whilst the fourth tube although showing abundant growth gives a negative result. The result of course, reads as follows ;— + ·001 c.c. — ·0001 c.c. It is instructive to compare the positive results shown in Figs., 17, 18 and 20 with the negative results in Fig. 19.

23rd May, 1902. A. C. HOUSTON.

C.—TABLE showing the Successive Dilutions of Tenths or Decimal Method of Stating Bacteriological Results, together with certain Standards of a provisional kind.

The double line in each case refers to a provisional standard (non-drinking water streams). It must be distinctly understood that the standards suggested are only of a tentative kind, and are in no way to be considered as final in character. They may, however, be of use as working standards for practical purposes, and to enable a comparison to be drawn between effluents of varying degrees of purity.

1.						2.		3.	4.	5.						6.				7.					
Description of the Sample.						Total Number of Bacteria in 1 c.c.		Number of Bacteria causing liquefaction of, Gelatine in 1 c.c.	Number of Spores of aerobic Bacteria in 1 c.c.	Number of B. Coli (or closely allied forms) in 1 c.c. (Primary broth cultures (24 hours at 37° C.) and subsequent surface gelatine plate method.)						Chief Biological characters of the *strain* of B. coli present in the number specified in Col. 5.				Indol Test. Indol in broth cultures direct (5 days at 37° C.).					
No.	Time of Collection. Hour.	Day.	Month.	Year.	Other Details.	Gelatine at 20° C.	Agar at 37° C.			1 1 c.c.	10 ·1 c.c.	100 ·01 c.c.	1,000 ·001 c.c.	10,000 ·0001 c.c.	100,000 ·00001 c.c.	Gas. (Gelatine "shake" cultures, 24 hrs. at 20° C.)	Indol. (Broth cultures 5 days at 37° C.)	(a) Acidity. (b) Clot. (Litmus milk cultures, 5 days at 37° C.) (a)	(b)	1 1 c.c.	10 ·1 c.c.	100 ·01 c.c.	1,000 ·001 c.c.	10,000 ·0001 c.c.	100,000 ·00001 c.c.
					Sewage effluent (passing the provisional standards suggested in the case of non-drinking water streams).	50,000 Less than one hundred thousand microbes, therefore "passing" the provisional standard. [Crude sewage usually contains over ten million bacteria per c.c. (gelatine at 20° C.)]	7,000 Less than ten thousand, therefore passing the provisional standard. [Crude sewage usually contains between one and ten million bacteria per c.c. (agar at 37° C.).]	No standard can safely be suggested, but a large number of gas-forming, rapidly liquefying, proteus-like germs should be considered a bad sign, especially if they are found to be pathogenic.	Here no standard can safely be laid down, but as spores are highly resistant, a large number of them in an effluent would seem to be an objectionable feature. Fortunately, however, the majority (at all events) of *Aerobic* sporing bacteria in sewage are believed to be of non-pathogenic sort.			+	− Negative result with ·001 c.c., therefore passing the provisional standard. [Crude sewage usually gives a positive result with ·00001 c.c.]			+	+	+	+			+	− Negative result with ·001 c.c., therefore passing the provisional standard. [Crude sewage usually gives a positive result with ·00001 c.c.]		

8. B. Enteritidis Sporogenes Test. Spores of B. enteritidis sporogenes (Klein's "enteritidis change" in anærobic milk culture). Cultures heated to 80° C. for 10 minutes.

1 1 c.c.	10 ·1 c.c.	100 ·01 c.c.	1,000 ·001 c.c.	10,000 ·0001 c.c.	100,000 ·00001 c.c.
+	− Negative result with 0·1 c.c., therefore passing the provisional standard. [Crude sewage usually gives a positive result with ·01 to ·001 c.c.] It is worth noting that this standard involves no troublesome dilutions. A positive result with 1 c.c. (about 20 drops) would not condemn a sample unless it gave a positive result also with 0·1 c.c. (about 2 drops).				

9. Streptococcus Test. Streptococci in surface agar cultures, 24 to 48 hours at 37° C.

1 1 c.c.	10 ·1 c.c.	100 ·01 c.c.	1,000 ·001 c.c.	10,000 ·0001 c.c.	100,000 ·00001 c.c.
Here no standard is suggested, but the presence of streptococci in any numbers in an effluent must be regarded as a bad sign, especially so if they bear any close resemblance to the kinds of streptococci believed to be causally associated with morbid processes occurring in the human subject.					

10. Bile-salt Broth Test. Acidity and gas formation, 48 hours at 37° C. (? 42° C.).

1 1 c.c.	10 ·1 c.c.	100 ·01 c.c.	1,000 ·001 c.c.	10,000 ·0001 c.c.	100,000 ·00001 c.c.
G = gas. A = acidity.		GA +	− Negative results with ·001 c.c., therefore passing the provisional standard. [Crude sewage usually gives a positive result with .00001 c.c.]		

11. Litmus Milk Modified Test. Gas formation and acid clotting of litmus milk cultures, 24 (? 48) hours at 37° C.

1 1 c.c.	10 ·1 c.c.	100 ·01 c.c.	1,000 ·001 c.c.	10,000 ·0001 c.c.	100,000 ·00001 c.c.
G = gas. A = acidity. C = clot.		GAC +	− Negative result with ·001 c.c., therefore passing the provisional standard. [Crude sewage usually gives a positive result with ·00001 c.c.]		

12. Gas Test. "Gas" production in gelatine "shake" cultures, 24 hours at 20° C.

1 1 c.c.	10 ·1 c.c.	100 ·01 c.c.	1,000 ·001 c.c.	10,000 ·0001 c.c.	100,000 ·00001 c.c.
+	− Negative result with 0·1 c.c., therefore passing the provisional standard. [Crude sewage usually gives a positive result with ·01 to ·001 c.c.] It is worth noting that this standard involves no troublesome dilutions. A positive result with 1 c.c. (about 20 drops) would not condemn a sample, unless it gave a positive result also with 0·1 c.c. (about 2 drops).				

13. Neutral-red Broth Test. Greenish-yellow fluorescence 24 (? 48) hours at 37° C.

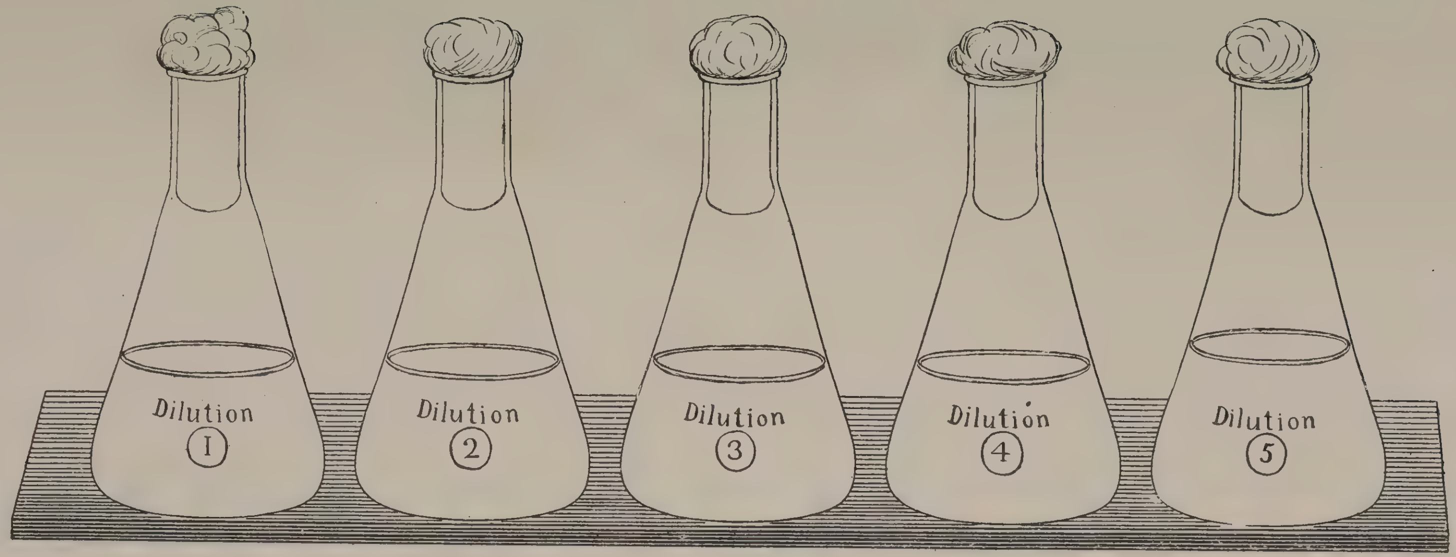
1 1 c.c.	10 ·1 c.c.	100 ·01 c.c.	1,000 ·001 c.c.	0,000 ·0001 c.c.	100,000 ·00001 c.c.
		+	− Negative result with ·001 c.c. therefore passing the provisional standard. [Crude sewage usually gives a positive result with ·00001 c.c.]		

14. Remarks.

The inoculation of animals is not dealt with in this table. But the importance of this test (which may be carried out in a variety of ways) has been by no means lost sight of (Yeovil report and subcutaneous inoculation of animals report). As a routine test the inoculation of animals is, perhaps, hardly to be recommended, but, in special cases and as an occasional means of gauging the pathogenic qualities of sewage effluents, the value of this test is great.

PLATE I.

FIG. A.



Successive dilutions of tenths or decimal method of making dilutions for bacteriological purposes:—

Flask (dilution). 1	Flask (dilution). 2	Flask (dilution). 3	Flask (dilution). 4	Flask (dilution) 5
90 c.c. H_2O + 10 c.c. sample	90 c.c. H_2O + 10 c.c. (1)	90 c.c. H_2O + 10 c.c. (2)	90 c.c. H_2O + 10 c.c. (3)	90 c.c. H_2O + 10 c.c. (4)
100 c.c. = 10 c.c. ,,	100 c.c. = 1 c.c. sample	100 c.c. = 0·1 c.c. sample	100 c.c. = 0·01 c.c. sample	100 c.c. = 0·001 c.c. sample
10 c.c. = 1 c.c. ,,	10 c.c. = 0·1 c.c. ,,	10 c.c. = 0·01 c.c. ,,	10 c.c. = 0·001 c.c. ,,	10 c.c. = 0·0001 c.c. ,,
1 c.c. = $\begin{cases} 0·1 \text{ c.c. ,,} \\ \frac{1}{10} \text{ c.c. ,,} \end{cases}$	1 c.c. = $\begin{cases} 0·01 \text{ c.c. ,,} \\ \frac{1}{100} \text{ c.c. ,,} \end{cases}$	1 c.c. = $\begin{cases} 0·001 \text{ c.c. ,,} \\ \frac{1}{1000} \text{ c.c. ,,} \end{cases}$	1 c.c. = $\begin{cases} 0·0001 \text{ c.c. ,,} \\ \frac{1}{10,000} \text{ c.c. ,,} \end{cases}$	1 c.c. = $\begin{cases} 0·00001 \text{ c.c. ,,} \\ \frac{1}{100,000} \text{ c.c. ,,} \end{cases}$

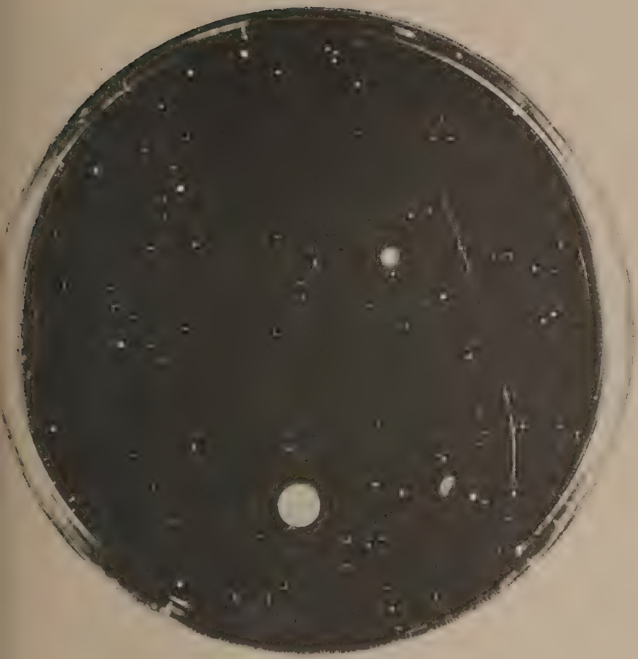


Fig. 1.

Fig. 2.

Fig. 3.

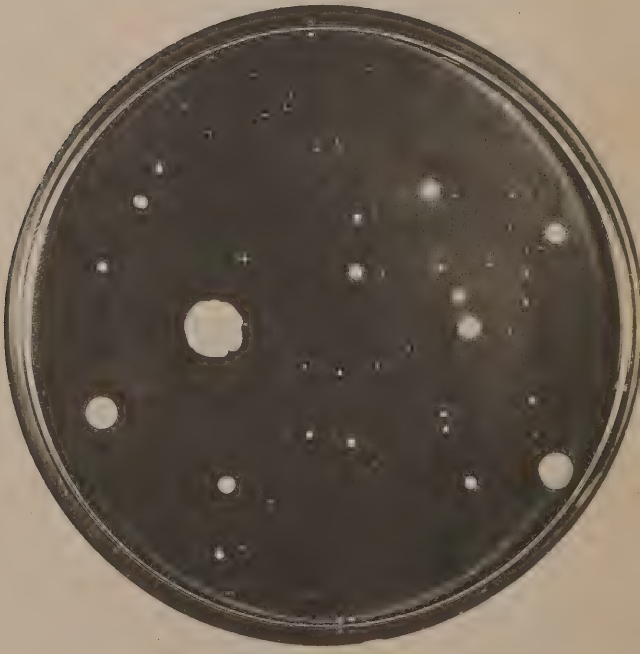


Fig. 4.

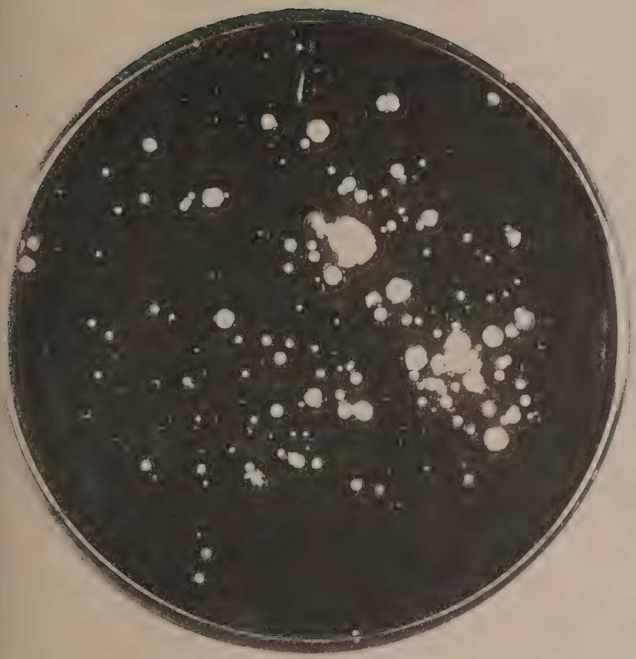


Fig. 5.

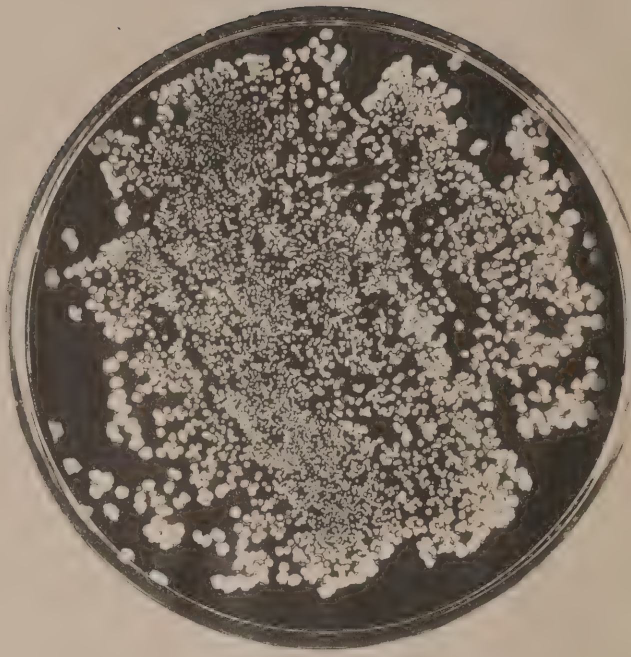


Fig. 6.

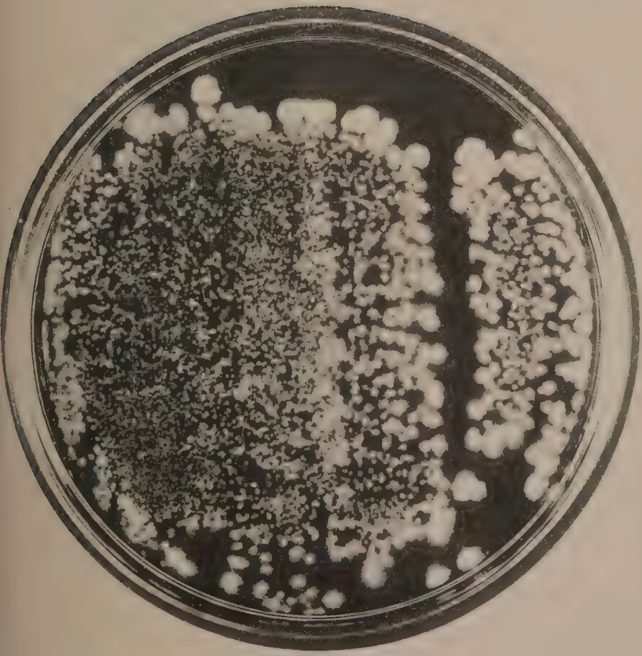


Fig. 7.

Fig. 8.

PLATE IV.

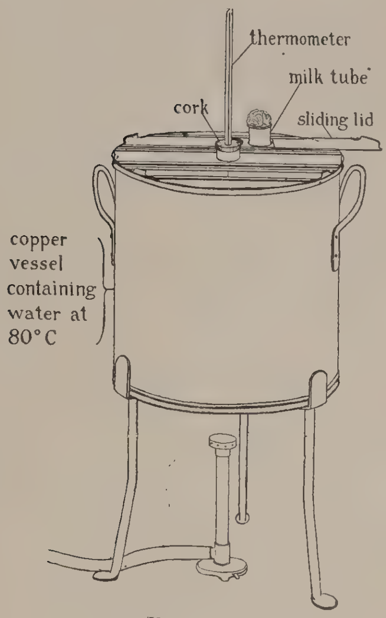


FIG. B.

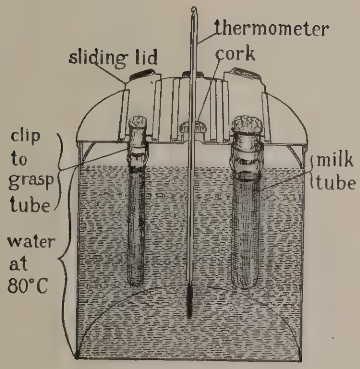


FIG. C.

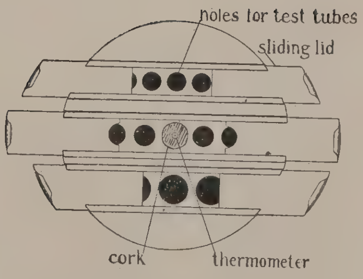
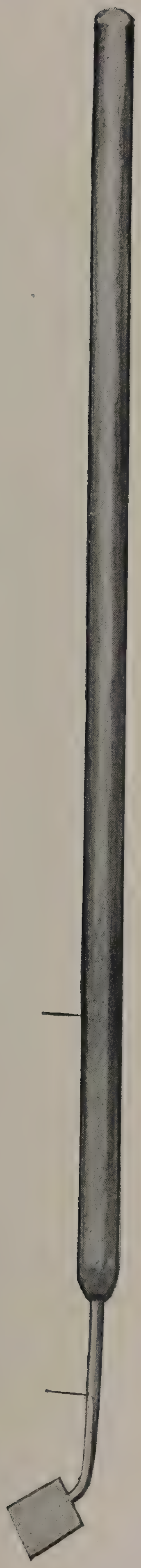


FIG. D.


Aluminium
Platinum

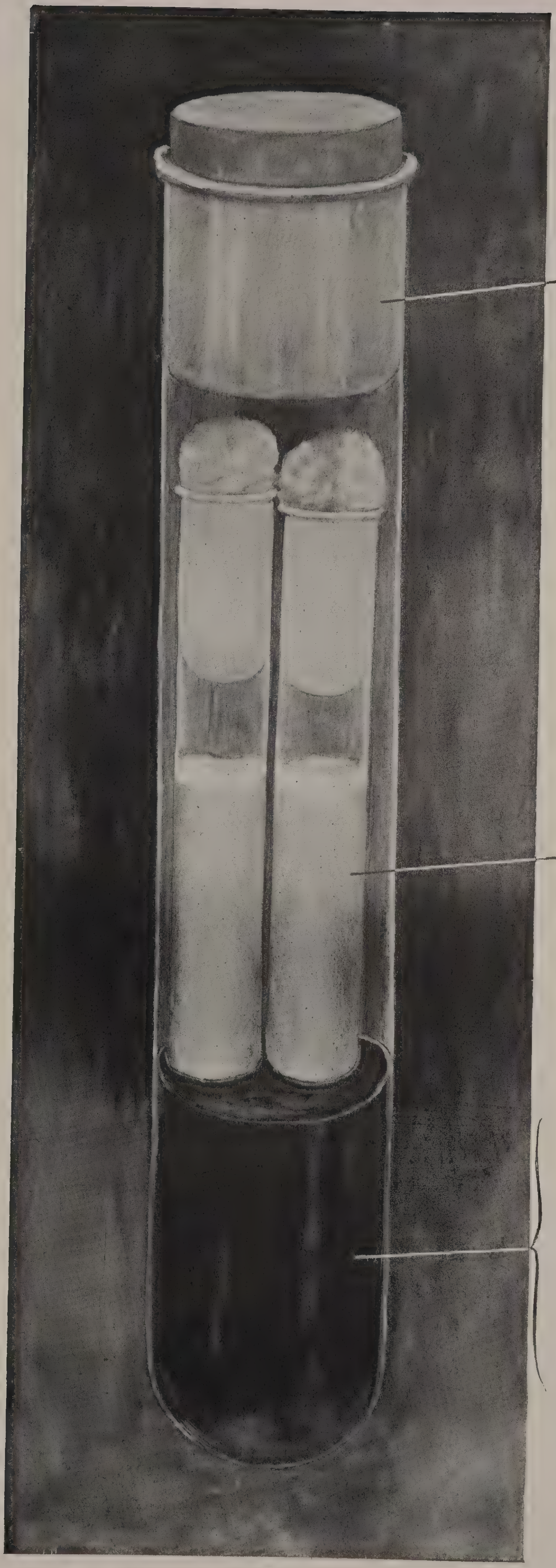

Rubber bung (No. 10 size) [wide glass tube, $8\frac{1}{2}$in. × $1\frac{1}{2}$in.]
Milk tube.
Mixture of pyrogallic acid and potassium hydrate solution.

FIG. E.

FIG. F.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

Plate VII.

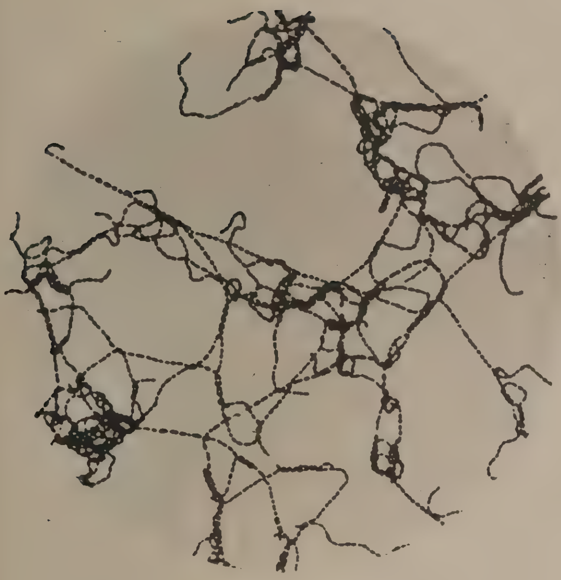


Fig. 13.

Fig. 14.

Fig. 15.

Fig. 16.

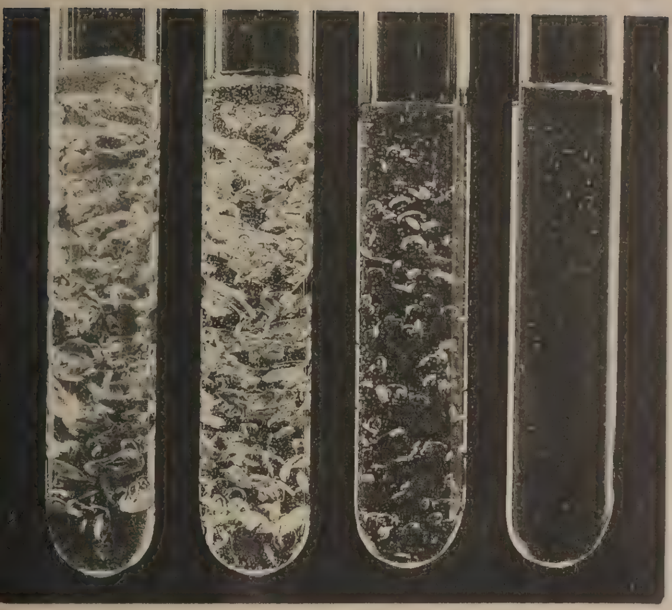


Fig. 17.

Fig. 18.

Fig. 19.

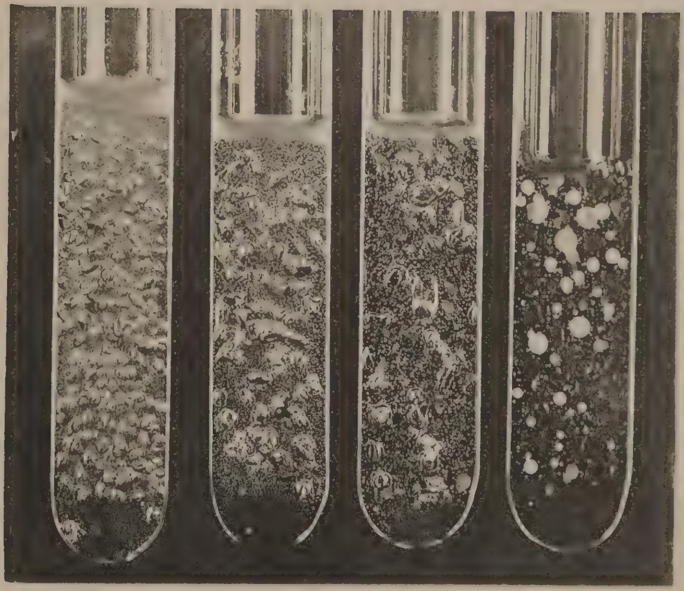


Fig. 20.

ROYAL COMMISSION ON SEWAGE DISPOSAL.

THIRD REPORT

OF

THE COMMISSIONERS

APPOINTED IN 1898

TO INQUIRE AND REPORT WHAT METHODS OF

TREATING AND DISPOSING OF SEWAGE

(INCLUDING ANY LIQUID FROM ANY FACTORY OR MANUFACTURING PROCESS)

MAY PROPERLY BE ADOPTED.

1. TRADE EFFLUENTS.

2. A NEW CENTRAL AUTHORITY.

Presented to both Houses of Parliament by Command of His Majesty.

LONDON:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE,
BY WYMAN AND SONS, LIMITED, FETTER LANE, E.C.

And to be purchased, either directly or through any Bookseller, from
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E. PONSONBY, 116, GRAFTON STREET, DUBLIN.

1903.

[Cd. 1486.]

VICTORIA R.

Victoria, by the Grace of God, of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith: To Our Right Trusty and Right Well-beloved Cousin, Walter Stafford, Earl of Iddesleigh, Companion of Our Most Honourable Order of the Bath; Our Trusty and Well-beloved Sir Richard Thorne Thorne, Knight Commander of Our Most Honourable Order of the Bath, Medical Officer of the Local Government Board; Our Trusty and Well-beloved Constantine Phipps Carey, Esquire, Lieutenant-Colonel and Honorary Major-General on the Retired List of Our Army; Our Trusty and Well-beloved Charles Philip Cotton, Esquire; Our Trusty and Well-beloved Michael Foster, Esquire, Master of Arts, Professor of Physiology in Our University of Cambridge; Our Trusty and Well-beloved Thomas Walter Harding, Esquire, Retired Lieutenant-Colonel of Our Auxiliary Forces, with Honorary Rank of Colonel; Our Trusty and Well-beloved Thomas William Killick, Esquire; Our Trusty and Well-beloved William Ramsay, Esquire, Professor of Chemistry, University College, London; and Our Trusty and Well-beloved James Burn Russell, Esquire, Doctor of Medicine, Master of Surgery: Greeting!

Whereas We have deemed it expedient that a Commission should forthwith issue to inquire and report:

1. (1) What method or methods of treating and disposing of sewage (including any liquid from any factory, or manufacturing process) may properly be adopted, consistently with due regard for the requirements of the existing law, for the protection of the public health, and for the economical and efficient discharge of the duties of local authorities; and

   (2) If more than one method may be so adopted, by what rules, in relation to the nature or volume of sewage, or the population to be served, or other varying circumstances or requirements, should the particular method of treatment and disposal to be adopted be determined; and

2. To make any recommendations which may be deemed desirable with reference to the treatment and disposal of sewage;

Now know ye, that We, reposing great trust and confidence in your knowledge and ability, have authorised and appointed, and do by these Presents authorise and appoint, you, the said Walter Stafford, Earl of Iddesleigh, Sir Richard Thorne Thorne, Constantine Phipps Carey, Charles Philip Cotton, Michael Foster, Thomas Walter Harding, Thomas William Killick, William Ramsay, and James Burn Russell to be Our Commissioners for the purposes of the said Inquiry.

And, for the better effecting the purposes of this, Our Commission, We do by these Presents give and grant unto you, or any three or more of you,

full power to call before you such persons as you shall judge likely to afford you any information upon the subject of this Our Commission; and also to call for, have access to, and examine all such books, documents, registers, and records as may afford you the fullest information on the subject, and to inquire of and concerning the premises by all other lawful ways and means whatsoever.

And We do by these Presents authorise and empower you, or any three or more of you, to visit and personally inspect such places as you may deem it expedient so to inspect for the more effectual carrying out of the purposes aforesaid.

And We do further by these Presents will and ordain that this Our Commission shall continue in full force and virtue, and that you, Our said Commissioners, or any three or more of you, may from time to time proceed in the execution thereof, and of every matter and thing therein contained, although the same be not continued from time to time by adjournment.

And we do further ordain that you, or any three or more of you, have liberty to report your proceedings under this Our Commission from time to time, if you shall judge it expedient so to do.

And Our further Will and Pleasure is that you do, with as little delay as possible, report to Us under your hands and seals, or under the hands and seals of any three or more of you, your opinion upon the matters herein submitted for your consideration.

And for the purpose of aiding you in such matters, We hereby appoint Our Trusty and Well-beloved Frederick James Willis, Esquire, to be Secretary to this Our Commission.

Given at Our Court at Saint James's, the Seventh day of May, One thousand eight hundred and ninety-eight, in the Sixty-first Year of Our Reign.

By Her Majesty's Command,
(Signed) M. W. Ridley.

William Henry Power, Esq., F.R.S.,
To be a Member of the Royal Commission on Sewage Disposal.

VICTORIA, R.

Victoria, by the Grace of God, of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith: To Our Right Trusty and Well-beloved William Henry Power, Esquire, Fellow of the Royal Society, Medical Officer of the Local Government Board: Greeting!

Whereas We did, by Warrant under Our Royal Sign Manual, bearing date the Seventh day of May, One thousand eight hundred and ninety-eight, appoint Our Right Trusty and Right Well-beloved cousin Walter Stafford, Earl of Iddesleigh, Companion of Our Most Honourable Order of the Bath, together with the several Gentlemen therein mentioned, or any three or more of them, to inquire into the treatment and disposal of sewage.

And Whereas One of the Commissioners so appointed, namely, Sir Richard Thorne Thorne, has since deceased.

Now know Ye, that We, reposing great confidence in you, do, by these Presents, appoint you, the said William Henry Power, to be one of Our Commissioners for the purpose aforesaid, in the room of the said Sir Richard Thorne Thorne, deceased, in addition to, and together with, the other Commissioners whom we have already appointed.

Given at our Court, at Saint James's, the Seventh day of February, One thousand nine hundred, in the Sixty-third Year of Our Reign.

By Her Majesty's Command,

(Signed) M. W. Ridley.

Whitehall, March 18th, 1901.

The King has been pleased to issue a Commission, under His Majesty's Royal Sign Manual, to the following effect:—

EDWARD, R.

Edward the Seventh, by the Grace of God, of the United Kingdom of Great Britain and Ireland King, Defender of the Faith, to all to whom these Presents shall come, Greeting!

Whereas it pleased Her late Majesty from time to time to issue Royal Commissions of Inquiry for various purposes therein specified:

And Whereas in the case of certain of these Commissions, namely, those known as—

The Historical Manuscripts Commission;
The Horse Breeding Commission;
The Local Taxation Commission;
The Port of London Commission;
The Salmon Fisheries Commission; and
The Sewage Disposal Commission;

the Commissioners appointed by Her late Majesty, or such of them as were then acting as Commissioners, were, at the late demise of the Crown, still engaged upon the business entrusted to them:

And whereas We deem it expedient that the said Commissioners should continue their labours in connection with the said inquiries notwithstanding the late demise of the Crown:

Now Know Ye, that We, reposing great trust and confidence in the zeal, discretion, and ability of the present members of each of the said Commissions, do by these Presents authorize them to continue their labours, and do hereby in every essential particular ratify and confirm the terms of the said several Commissions.

And We do further ordain that the said Commissioners do report to Us under their hands and seals, or under the hands and seals of such of their number as may be specified in the said Commissions respectively, their opinion upon the matters presented for their consideration; and that any proceedings which they or any of them may have taken under and in pursuance of the said Commissions since the late demise of the Crown, and before the issue of these Presents shall be deemed and adjudged to have been taken under and in virtue of this Our Commission.

Given at Our Court at Saint James's, the fourth day of March, One thousand nine hundred and one, in the First Year of Our Reign.

By His Majesty's Command,

(Signed) CHAS. T. RITCHIE.

EDWARD R.

Edward the Seventh, by the Grace of God, of the United Kingdom of Great Britian and Ireland and of the British Dominions beyond the Seas King, Defender of the Faith, To Our Trusty and Well-beloved Thomas Joseph Stafford, Esquire, Fellow of the Royal College of Surgeons of Ireland, Medical Commissioner of the Local Government Board for Ireland: Greeting!

Whereas Her late Majesty Queen Victoria did by Warrant under the Royal Sign Manual bearing date the Seventh Day of May One thousand eight hundred and ninety-eight, appoint Our Right Trusty and Right Well-beloved Cousin, Walter Stafford, Earl of Iddesleigh, Companion of Our Most Honourable Order of the Bath, together with the several Gentlemen therein mentioned, to be Commissioners to inquire into the treatment and disposal of Sewage:

And whereas one of the Commissioners so appointed, namely, Our Trusty and Well-beloved Charles Philip Cotton, Esquire, hath humbly tendered unto Us his resignation of his appointment as one of the said Commissioners:

Now Know Ye, that We, reposing great confidence in you, do by these Presents appoint you, the said Thomas Joseph Stafford, to be one of Our Commissioners for the purpose aforesaid, in the room of the said Charles Philip Cotton, resigned, in addition to and together with the present Members of the Commission.

Given at Our Court at Saint James's, the seventh day of May, One thousand nine hundred and two, in the Second Year of Our Reign.

By His Majesty's Command.

(Signed) CHAS. T. RITCHIE.

THIRD REPORT.

To the King's Most Excellent Majesty.

May it please Your Majesty.

We, your Majesty's Commissioners appointed to inquire into the methods of disposing of Sewage and Manufacturing Effluents and to make any recommendations in regard thereto, humbly submit this Report on the following aspects of our inquiry:—

I. The relations between local authorities and manufacturers in regard to the disposal of manufacturing effluents.

II. The need of setting up a Central Authority for

(1) the settlement of differences between manufacturers and local authorities;

(2) the general protection of sources of water supply;

(3) the collection of facts and the scientific investigation of questions of general importance relating to the protection of water.

I. THE RELATIONS BETWEEN LOCAL AUTHORITIES AND MANUFACTURERS IN REGARD TO THE DISPOSAL OF MANUFACTURING EFFLUENTS.

PRELIMINARY.

1. In connection with this question we have examined the following witnesses:—

On behalf of manufacturers:—

Mr. A. F. Firth, dyeing and printing works (Brighouse and Heckmondwike). 10257-10487.

Mr. Henry Beaumont, fulling miller and finisher (Elland). 10488-10572.

Mr. Joseph Crowther, Chairman of West Riding of Yorkshire Millowners' and Occupiers' Association. 10572-10731.

Mr. G. C. Hirst, woollen manufacturer (Huddersfield). 10732-10807.

Mr. James Bruce, general manager to Mr. Harold Nickolls, tanner (Leeds and other places). 10808-10901.

Mr. Enoch Butterworth, woollen manufacturer (Saddleworth). 10902-11063.

Mr. Herbert A. Foster, alpaca and mohair spinner and manufacturer (Queensbury). 11064-11168.

Mr. George Sheard, woollen manufacturer (Batley). 11169-11296.

Mr. W. E. Walker and Mr. Harvey, representing Manchester and Liverpool Tanners' Federation. 11297-11437.

Mr. John Stanning, Mr. Ross Gemmell, and Mr. A. J. King, representing the Calico Printers' Association, Limited, and the Bleachers' Association, Limited. 11439-11559.

Mr. E. A. Brotherton, M.P., ammonia works (Leeds and Wakefield). 12659-12701.

Mr. David Howard, chemical manufacturer. 12702-12756.

Mr. C. A. Davis, dyer (Greetland). 12727-12870.

Mr. W. F. Reid, Vice-President of the Society of Chemical Industry. 12871-12929.

Mr. H. Marshall, Mr. C. W. Crossley, Mr. P. G. Baldwin, and Mr. J. Smith, representing the Halifax Traders' Committee. 12930-13026.

Dr. W. S. Squire, representing the Society of Chemical Industry. 13877-13907.

Mr. Ellis, tanner (Shalford, Surrey). 13910-14042.

Mr. Thorp Whitaker, representing Bradford Dyers' Association, Limited. 14193-14347.

Mr. C. J. Phillips, Master of the Brewers' Company. 15841-15899.

On behalf of local authorities :—

11560-11618. Mr. J. H. Mills, Clerk and Surveyor to the Urban District Council of Crompton.

11619-11751. Mr. Alderman J. T. Simpson, Chairman of the Sewage Committee of the Town Council of Halifax.

Mr. J. Lord, Borough Engineer of Halifax.

Mr. Keighley Walton, Town Clerk of Halifax.

11752-11876. Mr. J. Jones, Borough Surveyor of Pudsey.

11877-11988. Mr. W. Hopkinson, Borough Surveyor of Keighley.

11989-12065. Mr. J. E. Sharpe, Engineer and Surveyor to the Urban District Council of Otley.

12066-12121. Mr. B. Powell, Engineer and Surveyor to the Urban District Council of Handsworth.

12230-12276. Mr. T. C. Beeley, J.P., Mayor of Hyde.

12277-12421. Mr. S. S. Platt, Borough Engineer of Rochdale.

Mr. T. Stenhouse, Public Analyst of Rochdale.

12422-12505. Mr. E. Ll. Morgan, Borough Engineer of Bolton.

Mr. J. Ashton, Chemist and Manager of Bolton Sewage Works.

12506-12658. Mr. R. Johnson, Chairman of Sewage Committee of Bradford.

Mayor of Bradford.

14348-14480. Alderman Sir Bosdin T. Leech, Chairman of the Manchester Rivers Committee.

Councillor C. Dreyfus, Deputy Chairman of the Manchester Rivers Committee.

Mr. G. J. Fowler, Superintendent and Chemist of Manchester Sewage Works.

14847-14892. Mr. Thomas Hewson, City Engineer of Leeds.

15900-15960. Mr. H. H. Waller, Vice-President of the West Riding Urban and Rural District Councils' Association ; Mr. Robert Emsley, Solicitor ; and Mr. Walter B. Pindar, Secretary to the same Association.

On behalf of Watershed Boards and County Councils :—

787-791. Mr. W. H. Wilson, Deputy Clerk and Solicitor to the Mersey and Irwell and Ribble Joint Committees.

13675-13876. Mr. R. A. Tatton, Chief Inspector to the Mersey and Irwell Joint Committee.

14043-14138. Dr. H. Maclean Wilson, Chief Inspector to the West Riding of Yorkshire Rivers Board.

4139-14192. Dr. Williams, Medical Officer of Health to the Glamorgan County Council.

2. We have also visited a large number of sewage works where sewage containing trade refuse is being treated.

3. We have visited the following manufactories :—

Messrs. Nicholson's Sulphuric Acid Manufactory, Leeds.

Clarke Bridge Mills
Draw Clough Mills } Halifax.

Birstal Dye Works
Messrs. Dewhurst & Co's. Works
Victoria Mills
Park Lane Mills
Queen Street Mills } On the Batley Beck.

Meanwood Tannery
Jackson's Tannery
Wilson, Walker & Co's Works
Fearn's Island Dye Works
Worthy Low Mills } Leeds.

The Butts, Messrs. Kelsall and Kemp
Mr. J. Hill's Works
Fieldhouse Mill
Woodhouse Mill
Mr. Wm. Clegg's Works } Rochdale.

J. Bury and Sons' Works
H. Cawley and Sons' Works } Salford.

D. Moseley and Sons' Works
Manchester Brewery Company } Ardwick.

Bradford Iron Works.

RIGHTS OF MANUFACTURERS UNDER THE EXISTING LAW TO DISCHARGE TRADE EFFLUENTS INTO SEWERS.

4. The main statutory provisions in regard to this matter are contained in Section 21 of the Public Health Act, 1875 and Section 7 of the Rivers Pollution Prevention Act, 1876.

These provisions are as follows:

"The owner or occupier of any premises within the district of a local authority shall be "entitled to cause his drains to empty into the sewers of that authority on condition of his "giving such notice as may be required by that authority." Section 21, Public Health Act, 1875.

"Every sanitary or other local authority having sewers under their control shall give facilities "for enabling manufacturers within their district to carry the liquids proceeding from their "factories or manufacturing processes into such sewers: Section 7, Rivers Pollution Prevention Act, 1876.

"Provided that this section shall not extend to compel any sanitary or other local authority "to admit into their sewers any liquid which would prejudicially affect such sewers or the "disposal by sale, application to land, or otherwise, of the sewage matter conveyed along such "sewers, or which would from its temperature or otherwise be injurious in a sanitary point of "view:

"Provided also, that no sanitary authority shall be required to give such facilities as aforesaid "where the sewers of such authority are only sufficient for the requirements of their district, nor "where such facilities would interfere with any order of any court of competent jurisdiction "respecting the sewage of such authority."

5. At the commencement of our inquiry Mr. Adrian, the Legal Adviser of the Local Government Board, gave us valuable evidence as to the effect of these sections, and we may particularly refer to questions 97–103, in the volume of evidence which accompanied our Interim Report.

Since then we have had the following correspondence with the Local Government Board on the matter:—

Royal Commission on Sewage Disposal,
39, Victoria Street,
Westminster, S.W.
15th January, 1903.

Sir,

I am directed by Lord Iddesleigh to inform you that the Commission are preparing a Report dealing with the rights of manufacturers to discharge trade effluents into sewers, and the duties of local authorities to provide sewers of sufficient capacity to receive trade effluents.

From the valuable evidence which Mr. Adrian, the Legal Adviser of the Local Government Board, has already laid before the Commission, it would appear that the law on this question was somewhat doubtful.

Lord Iddesleigh understands that since Mr. Adrian appeared before them the Board have consulted the Law Officers, and that they have advised to the effect that a local authority are under no obligation to construct a sewer of sufficient capacity to take trade effluents, and that the right of a manufacturer to drain his trade effluent into an existing sewer is only that which is given by Section 7 of the Rivers Pollution Prevention Act, 1876.

His Lordship would be much obliged if he might be informed whether this information is correct or not, and also if he might be referred to any cases which have been decided since Mr. Adrian gave his evidence tending to clear up points which at that time were not clear.

I am, Sir,
Your obedient servant,
(Signed) F. J. WILLIS, Secretary.

The Secretary,
Local Government Board.

Local Government Board,
Whitehall, S.W.
24th January, 1903.

Sir,

I am directed by the Local Government Board to acknowledge the receipt of your letter of the 15th instant, and in reply to state that, since Mr. Adrian gave evidence before the Royal Commission on Sewage Disposal, the Board have consulted the Law Officers of the Crown on the question of the rights of manufacturers to discharge trade effluents into sewers and the duty of local authorities to provide sewers of sufficient capacity to receive such effluents.

The effect of the Law Officers' opinion is that a local authority are not generally bound under the Public Health Act, 1875, to provide such sewers as may be necessary to carry off all the trade effluents and liquid refuse coming from manufactories in their district, and that their obligations in this respect are defined by the Rivers Pollution Prevention Act, 1876, Section 7, and are subject to the limitations stated in that section.

The Law Officers further expressed the view that the obligation under the Act of 1875 of providing sewers was confined to the ordinary requirements of the district, that is to say, that the local authorities are only bound to provide for sewage in the ordinary sense of the term, including foul water produced in the ordinary course of domestic management, and surface water.

As regards cases which have been decided in the Courts, the Board may refer the Commission to the Report of Peebles (or Pasmore) *v.* Oswaldtwistle Urban District Council in L.R. 1898 A.C. 387.

They may also draw attention to the cases of:—

Eastwood Bros., Ltd. *v.* Honley Urban District Council, L.R. 1900, 1, Ch. 781; L.R 1901, 1, Ch. 645; 69 L.J., Ch. 470; 70 L.J., Ch. 313.

Attorney-General on relation of the Sevenoaks Rural District Council *v.* Whitmore ("The Times," 2nd May, 1901).

West Riding of Yorkshire Rivers Board *v.* Gaunt and Sons (19 Times L.R. 140), West Riding of Yorkshire Rivers Board *v.* Yorkshire Indigo, &c. Dyers, Ltd. ("Times Newspaper," 22 Dec. 1902); and

Southall Norwood Urban District Council *v.* Middlesex County Council (49 W.R., 376; 65 J.P., 215).

I am, Sir,
Your obedient servant,
(Signed) NOEL T. KERSHAW.
Assistant Secretary.

F. J. Willis, Esq., Secretary,
Royal Commission on Sewage Disposal.

6. According to the opinion of the Law Officers, therefore, Section 21 of the Public Health Act, 1875, has no application to trade effluents.

Marshall, 13022.

7. It will, however, be seen that the Halifax Traders Committee who gave evidence before us, stated that they have been advised by Mr. Macmorran, K.C., that Section 21 of the Public Health Act, 1875, gives a manufacturer the same rights in regard to trade effluents as an ordinary ratepayer possesses in regard to domestic sewage.

Marshall, 12931.

They were also of opinion that the existing law was clearly defined.

But almost all the other witnesses whom we have examined, whether representing local authorities or manufacturers, have expressed the view that the positions and rights of the manufacturer and the local authority as to the discharge of trade effluents into sewers are not clearly defined, and we find that, generally, local authorities have not regarded Section 21 of the Public Health Act as imposing any duty upon them in regard to trade effluents.

As shewing the nature of the questions upon which they have felt that doubt arises, we may refer to the following extracts from the evidence:—

Mr. Tatton, Chief Inspector of the Mersey and Irwell Joint Committee (13,680):—

"I am of opinion that there are some points as to the rights of manufacturers and local authorities which are not clearly defined under the existing law—the most important of these are:—

"Is a local authority bound to admit trade waste into the sewers? If so, we may conclude "that there is also an obligation to make new sewers of sufficient size for the trade waste in "addition to the domestic sewage, but this is a point about which there seems to be considerable "uncertainty. Again, it seems uncertain whether an authority has power to exclude a "manufacturer (already in the sewers) from them, although his trade waste may be the cause "of great extra expense in treating the sewage; further if the authority has not power to "turn out the manufacturer, has it power to make him carry out preliminary treatment?

"Has an authority in any case power to compel a manufacturer, whether he is already "in the sewers or only trying to gain admission, to carry out preliminary treatment?"

Mr. Ellis (an Alderman of the Surrey County Council), a tanner, having factories at Bermondsey and at Shalford, Surrey (13,912).

"At the present time Section 7 in the Rivers Pollution Act of 1876 is really all the manufac- "turers have to trust to (if we except Clause 21 of the Public Health Act of 1875, to which I "will presently allude), and difficulties and litigation cluster around its interpretation and that "of its qualifying provisions. These, in my opinion, should be made perfectly clear. The "Section 7 is as follows: 'Every sanitary or other local authority having sewers under their "'control, shall give facilities for enabling manufacturers within their districts to carry the "'liquids proceeding from their factories or manufacturing processes, into such sewers.'

"The expression 'give facilities for' is treated as ambiguous by the legal mind, and is "certainly more so than the wording of the 21st Section of the Public Health Act, 1875, "where it says that 'the owner or occupier of any premises within the district of a local "'authority shall be entitled to cause his drains to empty into the sewers of that authority.' "In itself this appears clear enough, and in some cases the decisions of the Courts have "been in favour of the manufacturers; but Lord Halsbury has expressed the view that it "was never intended that a manufacturer should be allowed to use the drains for his sewage, "and this point should be made perfectly clear.

The witness apparently refers to the observations made by the Lord Chancellor in the appeal to the House of Lords in Pasmore *v.* Oswaldtwistle Urban District Council [1898] A.C. 387).

"The limitations to Section 7 of the Rivers Pollution Act are very considerable."

Mr. Alderman Simpson, Chairman of the Halifax Sewage Committee (11693—11697).

"Then in regard to the position of the law on this matter, do you find that the law is "clear on the subject of the responsibility of local authorities?—By no means; it wants a very "considerable alteration there.

"Your difficulty at Halifax appears to arise from the fact that a certain prescriptive right "has been obtained by these people of turning their effluents into the sewer?—That is so.

"But in cases of new manufactures you have not the same difficulty, have you?—No, we "could, in the case of any new manufacturer, of course, insist upon this code of rules being "subscribed to.

"You can do that?—Oh, yes.

"The law permits you to do that?—(*Mr. Lord.*) We think so; but the millowners, on the "other hand, think not, and there is the difficulty."

8. Though the case of Eastwood Bros., Limited, *v.* Honley Urban District Council, to which the Local Government Board have referred us, suggests a doubt on the point, we assume that under the existing law the local authority are not bound to provide sewers of sufficient capacity to take trade effluents, and that their only obligation is that imposed by Section 7 of the Rivers Pollution Prevention Act, 1876.

9. Under the provisos of this section the local authority may refuse to allow trade effluents to enter sewers on any of the following grounds:—

1. That they would injure the sewer.
2. That they would prejudicially affect the disposal of the sewage.
3. That their volume is too great for the capacity of the sewers.
4. That their admission to the sewer would interfere with some order of a court of competent jurisdiction.

10. The evidence shows that in practice these provisos are such as to enable an unwilling authority frequently to evade the obligations imposed by this section. Davis, 12844. Ellis, 13912. Wilson, 14054–5.

A manufacturer claiming under this section to be allowed to connect with the sewers can at present only enforce his claim by bringing an action in a Court of Law, and for many reasons we doubt whether this is the best way of settling such a matter.

The questions to be determined in each case are for the most part of a scientific nature, and not infrequently expert evidence of a conflicting character is brought forward by each side at considerable cost.

As a typical case we may refer to an action in which the Sevenoaks Rural District Council sought to obtain an injunction, restraining Messrs. Whitmore, a firm of tanners, at Edenbridge, from causing or permitting the effluent from their tannery to enter the sewers.

The Judgment in this case of the Master of the Rolls in the Court of Appeal is of particular interest:—

He said "He had come to the conclusion after reading the whole of the evidence that it was "impossible to say that the judgment of Mr. Justice Mathew was wrong. The real cause of "action in this case was founded on section 7 of the Rivers Pollution Act, 1876. That "section conferred a benefit on persons carrying on trade—namely, a right to drain into the "public sewers. It enacted that 'Every sanitary or other local authority having sewers "'under their control shall give facilities for enabling manufacturers within their district to "'carry the liquids proceeding from their factories or manufacturing processes into such sewers.' "That was a statutory right given to manufacturers. But it was subject to a limitation. The "section proceeded, 'Provided that this section shall not extend to compel any sanitary or other "'local authority to admit into their sewers any liquid which would prejudicially affect such "'sewers or the disposal by sale, application to land, or otherwise, of the sewage matter conveyed "'along such sewers.' Here the plaintiffs, who were a local authority, said that the defendants, "who carried on the trade of tanners, although they had a *prima facie* right to drain the liquids "coming from their tannery into the public sewers, yet ought not to be allowed to do so because "those liquids were injurious to the application to land of the sewage matter conveyed along the "sewers. They said that the effluent from the tannery was such that when it came on to their "sewage farm it killed the microbes which otherwise would have got rid of the impurities "in the sewage. The whole issue was whether that was true. There was a large body of "evidence given at the trial on one side and on the other, and that evidence was very "complicated, the expert witnesses who were called not only giving evidence quite inconsistent "with one another but some of them giving evidence in cross-examination which was quite "inconsistent with what they said in examination-in-chief. The defendants' point was that "the cause of the microbes being killed was not the effluent of their tannery, but the method "which the plaintiffs adopted of managing and working their sewage farm. Mr. Justice Mathew "considered that point, and thought that it was made out, and he gave judgment for the "defendants. There was no ground whatever for interfering with his decision." "Times," 2nd May 1901.

The Lords Justices delivered judgment to the same effect.

Messrs. Whitmore were therefore allowed to continue to discharge their effluent into the sewers.

The costs in this action were about £7,000. The recognised costs fell upon the local authority, but the tanners were mulcted in over £1,000 Ellis, 13976.

11. There can be little doubt that many manufacturers would rather forego any claims to discharge their effluents into the sewers than embark on litigation of this character.

Moreover, a decision in one case would not necessarily be of any help in another case, as in each case the question to be decided would be whether the particular effluent would prejudice the disposal of the sewage or contravene any other of the statutory conditions.

12. It is obvious, therefore, that while the existing law is apparently precise the difficulties attendant on its application in any particular case render uncertain the position and rights of any particular manufacturer.

Tatton, 13762. Wilson, 14055-6. One of the results of this uncertainty has been that the work of enforcing the purification of manufacturing effluents has been considerably hampered and delayed.

Firth, 10434-10443. A manufacturer when requested to put down purification works has replied that he is in negotiation with the local authority with a view to discharging his effluents into the sewer.

The local authority then frequently "drift along for years without giving any definite answer one way or another" (13764). They doubt their liability in the matter, and often allege great difficulty in deciding whether the purification of the mixture of ordinary sewage and the manufacturing effluent will be practicable or not.

Crowther, 10594. Walker, 11391. King, 11506. Ellis, 13912.

Moreover we find as a fact that the attitude of local authorities towards manufacturers has differed widely and that many manufacturers have been seriously handicapped.

Beaumont, 10505. Mills, 11562. Simpson, 11627. Jones, 11776. Hopkinson, 11890. Some authorities definitely refuse to allow any manufacturing effluent to enter their sewers, others have allowed connections subject to the manufacturer observing conditions and adopting preliminary treatment, while others have allowed connections without conditions.

Beeley, 12231. Wilson, 14063. Waller, 15,900. From the table handed in by the West Riding District Councils Association, it appears that in twenty-nine of the districts represented by that Association in which trade effluents occur, the Councils refuse to allow trade effluents to enter the sewers, in four they are admitted subject to conditions, in sixteen they are admitted unconditionally.

13. Many manufacturers have expressed themselves strongly against this differential treatment; and the witnesses who have spoken on behalf of local authorities hold similar views, as the following typical extracts from their evidence will show:—

12326, Platt (Rochdale). "I think it is altogether unfair that a manufacturer already in should have a preference "over a manufacturer who wants to come in; in fact, it is a very serious complaint with "some of our manufacturers. They say, 'Here, we want to come in: you ask us to do this, "'why do you not ask others to do it engaged in the same trade? You handicap us for a start,' "and I think it is not an unreasonable position to take up.

13680, Tatton. "The manufacturers should all be on the same basis as much as possible, and the authorities "should have power to protect their interests. If the law were made clear that, firstly, manu-"facturers have a right to be admitted into the sewers, and secondly, that authorities have "a right to make byelaws to protect their interests, a great deal of the present uncertainty "would be removed, and the respective parties would be more likely to come to terms.

14057, Dr. Wilson. "I think very strongly that the manufacturer will feel aggrieved, and justly so, if the law is "not made applicable to old connections, as well as to all cases of new connections.

14114, Dr. Wilson. "All manufacturers should be put on the same footing.

14436, Councillor Dreyfus (Manchester). "I should say the local authorities ought to be compelled to take that trade effluent in their "midst, provided that conditions, safety conditions that they lay down, are obeyed by the "manufacturer."

Waller, 15900. 14. At a conference which was convened by the West Riding District Councils Association on 27th May, 1902, at which over 100 Councils were represented, the following resolution was carried unanimously:—

"That a report on the conditions prevailing in the West Riding be submitted to the Royal "Commission on Sewage Disposal with a request that they would consider the desirability of "amending the law so as to bring about a uniform practice."

Mr. Waller, the Vice-President of this Association, stated in evidence before us that:

"This diversity of opinion and practice is of the greatest moment to the manufacturers and "others in the West Riding of Yorkshire, where mills, manufactories, and works of all descriptions "abound, and more particularly in the small towns and villages in the midst of which I reside "and carry on my business, and, in fact, the question is agitating greatly many Urban and "District Councils within the West Riding at the present time.

"In every case where the discharge of trade effluents into the sewer has become a 'right' "or an 'easement,' it is of great present and prospective value to the fortunate manufacturer "in districts where no other trade effluents are now allowed to be connected. Advantages "gained so fortuitously ought not to be allowed to continue to the prejudice of trade competitors "in the same district.

"I know myself of trade competitors carrying on their respective businesses in premises close to "one another where the one is discharging his crude trade effluents into the common sewer, and "the other is being made to treat them at his own expense, thereby giving a most unfair "advantage to the one over the other.

"For whilst the manufacturer whose trade effluents are discharged into the public sewers has to "bear his own share of the total cost of purifying the sewage of the district, including his "trade effluents, the excluded manufacturer must not only pay his share of the rate laid for "sewage purposes, but at the same time is liable to purify his own trade effluents at his own cost. "This is manifestly unfair.

"In districts with which I am familiar, it happens that in two adjoining districts the authority "of the one may permit the discharge of trade effluents into their sewers, whilst the authority in "the other forbids it.

"The natural result will be that it will divert both capital and labour, and consequently "rateable value, into the district where such sewage is treated to the detriment of the adjoining "district.

"It is felt strongly by my Association that the matter should be dealt with promptly, and "that whatever method of settlement be adopted it should be upon the basis that all manufacturers "should be dealt with alike in every district, that no advantage should be retained by reason of "previous usage or admission of trade effluents into the public sewers, and that the rights, duties, "and obligations of all sanitary authorities and manufacturers should be uniform respectively."

15. In addition to the difficulties attendant on the application of the existing law in any particular case, the following further causes of differential treatment are important :—

1. Only those manufacturers who happen to have a sufficiently large sewer near their premises have any claim to discharge their effluent into the sewer, and
2. A local authority in constructing a system of sewerage have the absolute right to elect that they will not construct the sewers of sufficient capacity to take trade effluents.

16. We are satisfied that unless the law is altered differential treatment of manufacturers will continue, and that as a consequence trade will continue to be seriously hampered if not indeed injured.

We fully share in the view which has been pressed upon us from all sides, that as far as practicable all manufacturers should be placed on an equal footing. This is desirable not only in fairness to manufacturers but also in the interest of river purification.

We think that it is practicable to secure far greater uniformity than at present exists, and we therefore now proceed to indicate by what means this end may be secured.

REMEDIES.

THE PRACTICABILITY OF PURIFYING MIXTURES OF TRADE EFFLUENTS AND SEWAGE.

17. In considering what remedies are available, it has been necessary to determine whether the purification of sewage when mixed with trade effluents is practicable.

On this question we have taken a considerable amount of evidence from officers and others representing local authorities who have had actual experience in the matter.

We find that sewage containing trade effluents is generally more difficult to purify than ordinary sewage, and that the following are the chief causes of difficulty :—

1. The trade effluents may be turned into the sewer at irregular intervals, so that the composition of the sewage as it arrives at the sewage works varies considerably throughout the day.
2. The trade effluents may contain large quantities of solids in suspension which tend to choke the purification plant.
3. The trade effluents may be very acid or very alkaline, or otherwise chemically injurious.

The general opinion of these witnesses, however, is that it is practicable, in the great majority of cases, to purify mixtures of sewage and trade effluents if the manufacturers adopt reasonable means for removing the solids, equalising the discharge, and, when necessary, neutralising the trade effluent.

(Harding, 7034-7501; Tatton, 13680, 13727, 13773; Wilson, 14051; Fowler, 14383-9, 14391; Simpson, 11644, 11651-2, 11675-81; Jones, 11789; Beeley, 12244, 12247; Platt, 12315, 12331-6; Stenhouse, 12406-7; Ashton, 12450; Morgan, 12448-9; Johnson, 12599-600, 12652; Hopkinson, 11905, 11923-4, 11972-3; Sharpe, 12034-40; Powell, 12074-5, 12087; Sir B. T. Leech, 14394-5; Dreyfus, 14409-10.)

Simpson, 11667. Stenhouse, 12406-12410. Sharpe, 12054, 12058.

Moreover, there is some evidence to indicate that even if the manufacturers do not adopt such means the purification of the mixture of sewage and trade effluents is still practicable, though the difficulties and cost are much greater.

Platt, 12327. Simpson, 11658-60. Hopkinson, 11907. Howard, 12754. Tatton, 13680. Williams, 14154-9.

But the evidence clearly shows that wherever practicable the manufacturer should adopt means for removing the bulk of the solids in suspension from his effluent, for neutralising it, and for delivering it into the sewer in a fairly uniform manner. And further, it would seem probable that in some cases the cost to the manufacturer of adopting these preliminary measures would be less than the additional cost which would be thrown on the local authority if the measures were not adopted. Indeed, there is evidence to show that occasionally the removal of the solids has been a source of profit to the manufacturer.

We have examined a large number of effluents from works where sewage containing trade refuse is being treated, and our results fully support the view that it is practicable in the great majority of cases to purify mixtures of sewage and trade effluents if the manufacturers adopt reasonable preliminary measures.

SEPARATE PURIFICATION OF TRADE EFFLUENTS BY MANUFACTURER.

Crowther, 10605-6. Butterworth, 11029-33. Walker, 11315-7. Johnson, 12603. Hopkinson, 11910-11. Ashton, 12476-7. Johnson, 12651. Marshall, 12980. Crossley, 13003.

18. We have not yet examined in detail the methods available for the purification of trade effluents, but from an inspection of some manufactories where considerable sums have been expended on purification plant which is inefficient, and also from the evidence, we are satisfied that in some cases at least the purification of the trade effluent by itself would be very difficult to accomplish.

Moreover, the evidence shows that the separate purification of trade effluents is generally more difficult and more costly than their purification when mixed with the ordinary sewage of the locality.

And it has been proved by the evidence and by our own inspection of manufactories that there are many cases, especially in towns, where the manufacturer has not sufficient space on which to erect purification works.

(Firth, 10315-19; Stanning, 11448-50; Simpson, 11663; Davies, 11821-2; Johnson, 12516-9; Platt, 12317; Reid, 12880-6; Crossley, 12998, 13010; Tatton, 13765, 13865; Whitaker, 14240-5; Leech, 14356.)

EXTENSION OF RIGHTS OF MANUFACTURERS.

19. As might be expected the manufacturers who have given evidence before us have urged that greater rights should be given to them to discharge their effluents into the sewers.

It will, however, also be seen that many important witnesses representing local authorities have expressed the view that under proper safeguards it should be the duty of the local authority to allow manufacturing effluents to enter the sewers.

The following extracts will serve to shew the nature of this evidence :—

11692, Simpson (Halifax).

"(*Chairman.*) You think it is prudent for a local authority as far as possible to foster trade in "the neighbourhood, by giving facilities to manufacturers, provided they carry out these pre-"liminary conditions?—(*Mr. Alderman Simpson.*) I think so, decidedly.

11789, Jones (Pudsey).

"(*Chairman.*) You think that in your district the effluents are of such a character as not to "prejudice the treatment of the sewage, provided that certain conditions are carried out by the "manufacturers?—I think so. If we had to compel a separate system of sewage the distance "between the manufactories is so great it would be very expensive, and I think if they would "put down preliminary treatment works, as requested by the Sewage Committee, the Council "ought to take them.

11939, Hopkinson (Keighley).

"(*Chairman.*) And do you think, therefore, that there ought to be any general legislation "compelling authorities under all circumstances to receive trade effluent?—I think so.

"You think notwithstanding such difficulties?—I think if the Corporation clauses put in our 11940.
"Act of 1898 could become general, I do not think any manufacturer would object to it; I do "not know whether or not you have a copy of the clause.

"(*Colonel Harding.*) Then your view is that it is advisable, speaking generally, for the local 12600, Johnson (Bradford).
"authority to facilitate the reception of trade effluents into the sewers, subject, in some cases, to "conditions?—Yes, if there is an effluent which is very bad the local authority should have "power to call upon the pollutor to give some treatment to it first, but taking it as a general rule, "I think it is an advantage to treat the whole of the mixed sewage, and I think it is the duty "of the municipality to admit trade effluents.

(*Colonel Harding.*) From your large experience, Mr. Tatton, in the Mersey and Irwell district, 13702, Tatton (Mersey and Irwell Committee).
"do you think it is possible to so define the law as to make it applicable to all cases? Is it "possible to say that an authority shall in all cases put down sewers large enough to take the "trade effluents of the district; is it possible to do that?—Well, there are certain cases where "you have a manufacturer perhaps with a very large works turning out a large volume of "water in a small place where it would not be fair: but I think that is rather dealt with later "on. I am suggesting that he should be compelled to pay an extra rate for that large volume "which he turns into the sewers, but I think as a general rule in large towns that there will "be no harm in saying that a local authority shall be compelled to admit manufacturers, under "certain safeguards, into the sewers.

"(*Colonel Harding.*) Would it, in your opinion, be an advantage that there should be laid on 14096, Wilson (West Riding of Yorkshire Rivers Board).
"the local authority a distinct obligation to receive trade effluents, subject to their giving reasons "why they did not wish to receive it?—Yes.

"Subject to their giving conditions antecedent to their receiving it?—Certainly, simply from 14097.
"the point of view of the purification of the rivers it would be a very good thing if the larger "number of the trade pollutions could be received into the public sewers, and dealt with along "with the domestic sewage.

"Then if the law could be so altered as to lay a more definite obligation than there seems to be 14098.
"at present on the local authority, do you think that would be an advantage?—Yes.

"Subject always to their having a power of appeal?—Yes, certainly. 14099.

"If your colleague on the Mersey and Irwell Board, Mr. Tatton, says that he thinks a definite 14100.
"obligation of that kind would be desirable, do you agree with him or disagree with him?— "The distinct obligation for the Sanitary Authority to take the trade refuse?

"Yes; subject to their having power to make conditions?—Yes. 14101-2.

"And subject to their having power of appeal on either side?—I agree with him." 14103.

"(*Chairman.*) Should the law be altered so as to give manufacturers greater rights than at 14367, Dreyfus (Manchester).
"present to connect up with sewers?—Manufacturers, as ratepayers, and so long as they comply "with the regulations based on Acts of Parliament, should have full rights to connect up with "sewers. The contrary would be a great hardship, and would in many cases prevent the spread "and extension of our industries on which we live.

"(*Sir Michael Foster.*) No, but I mean treating the law generally over the land; from your 14436, Dreyfus (Manchester).
"experience what do you say, Councillor Dreyfus? (*Councillor Dreyfus.*) I should say the local "authorities ought to be compelled to take that trade effluent in their midst, provided that "conditions, safety conditions that they lay down, are obeyed by the manufacturer, because "after all this country lives on its trade, and we must put no obstacle in the way of competing "much more with the foreigners than we have already.

20. The position therefore is as follows:—

Purification of trade effluents by the local authority is in the great majority of cases practicable; purification by the manufacturer is in some cases difficult, if not impracticable; while purification by the manufacturer would generally be more costly than purification by the local authority. It also appears that the local authorities as well as the manufacturers are of opinion that there should be laid on the local authority a distinct obligation to receive trade effluents.

21. Further advantages which would follow from such a change in the law would be that the average standard of purification which would be reached throughout the country would be higher than if each manufacturer separately attempted to purify his own trade effluent, and also that the work of preventing the pollution of rivers would be greatly assisted in that the number of purification works to be kept under observation would be diminished.

ALTERATION OF LAW.

22. We are therefore of opinion that the law should be altered so as to make it the duty of the local authority to provide such sewers as are necessary to carry trade effluents as well as domestic sewage, and that the manufacturer should be given the right, subject to the observance of certain safeguards, to discharge trade effluents into the sewers of the local authority if he wishes to do so.

We do not think it possible to provide by direct enactment what these safeguards should be. In each district it would probably be desirable that the local authority should frame regulations which should be subject to confirmation by a Central Authority. In most cases, however, these regulations could provide definite standards for the different manufacturers as regards preliminary treatment, and it appears from the evidence that manufacturers would much prefer to have standards to work to.

Firth, 10321; 10,414. Crowther, 10605. Butterworth, 10996; 11008. Walker, 11355.

Power to vary the standards or to dispense with them altogether in special cases would be necessary.

23. Although the duty of receiving trade effluents should, we think, be imposed on the local authority, cases may arise in which they should be wholly or partially relieved of it.

Stanning, 11450; 11460-6. Powell, 12075. Tatton, 13771-2.

For example, we find that in some instances the effluent discharged from the manufactory is of a composite character, the greater part of which might with advantage be easily dealt with by the manufacturer if it were kept separate. In such cases we think the manufacturer would generally be willing to adopt this course, but provision is necessary for those cases in which the local authority and manufacturer could not agree.

Further, although we have received no conclusive evidence to shew that there are trade effluents which could not be purified by the local authority, we do not deny the possibility of such cases arising.

And it is possible that in some cases as, for example, of a large manufactory being newly established in a small district it might be necessary to relieve the authority of the obligation to treat the trade effluent or to enable them to exact some special contribution from the manufacturer not only for the cost of treatment but also towards capital expenditure.

24. It is obvious therefore that some tribunal will be required for settling differences between the local authority and the manufacturer, and for relieving the local authority in exceptional cases either wholly or partially of their obligation to provide sewers and disposal works of sufficient capacity for trade effluents as well as ordinary sewage.

We shall explain in a later section the plan which we think should be adopted.

RIPARIAN RIGHTS.

25. In many cases a part or the whole of the water which the manufacturer uses in his business is obtained from a stream and must therefore be returned to the stream.

We do not propose that the manufacturer should by statute be relieved of this liability. If he is able to relieve himself from the obligation by obtaining the necessary consents from other riparian owners or by providing compensation water, then he might discharge his effluent into the sewer, but the responsibility must rest entirely on the manufacturer: the local authority should be expressly exempted from any liability for the infringement of riparian rights by the discharge into the sewer of water obtained from a stream.

SPECIAL CHARGE ON MANUFACTURER.

26. We have taken a considerable amount of evidence on the question whether the manufacturer who discharges his trade effluent into the sewer should be required to pay something beyond his ordinary rates, and as might be expected the views expressed are divergent.

The question is one of importance, and we think it desirable to summarize the answers given to it:—

10,309, *Firth* (*Manufacturer*). Replied in the negative, on the ground that if it were to the advantage of the public that trade refuse should be treated, the cost of treatment should come out of the ordinary rates, to which the manufacturers contribute, sometimes very largely.

10,567. *Beaumont* (*Manufacturer*). Evidence to same effect.

10,628, *Crowther* (*West Riding of Yorkshire Millowners' and Occupiers' Association*). Answered the question in the negative.

10,802–3, *Hirst* (*Manufacturer*). Thinks that it would be fair to charge the manufacturer a special rate for the treatment of his effluent.

10,842, *Bruce* (*Manufacturer*). Thinks that an extra charge should be made where no preliminary treatment at all is carried out by the manufacturer, but not where manufacturers incur expense in treating their effluent to a certain extent before its discharge into the sewers.

11,002, *Butterworth* (*Manufacturer*). Agrees that special charge should be made if manufacturers are relieved from cost of chemicals or special appliances for treating their effluent themselves.

11,098–9, 11,122, *Foster* (*Manufacturer*). Manufacturers ought to bear some portion of the cost of treatment where volume of trade effluent is excessive in proportion to total volume of sewage. But if he pays large proportion of cost in way of rates, he is entitled to have provision made for his trade effluent.

11,127, *Sheard* (*Manufacturer*). No. Manufacturers would pay a large proportion of cost by way of ordinary rates.

11,390, *Walker* (*Manchester and Liverpool Tanners' Federation*). Would rather pay an increased rate than dabble in purification himself.

11,698, *Simpson* (*Halifax Corporation*). Manufacturers should either be charged something for the treatment of their effluent where it becomes a large question, or, at all events, contribute something more towards the rates.

11,817–18, *Jones* (*Pudsey Corporation*). No. Nothing should be required of manufacturer beyond provision for the preliminary treatment of his effluent.

11,927, *Hopkinson* (*Keighley Corporation*). Ditto.

12,011, *Sharpe* (*Otley District Council*). Where a manufacturer is connected with the sewers he should pay a special rate or charge.

12,079, *Powell* (*Handsworth District Council*). Thinks most certainly that manufacturers should pay a special rate or charge.

12,259, *Beeley* (*Hyde Corporation*). Not where preliminary treatment is carried out by manufacturers.

12,347, *Platt* (*Rochdale Corporation*). It would be preferable for the manufacturer to spend the money on works for preliminary treatment of his effluent.

12,490–1, *Morgan* (*Bolton Corporation*). A special rate should be charged only in cases where no preliminary treatment is adopted.

12,531 ; 12,580, *Johnson* (*Bradford Corporation*). Yes. A special rate is the only solution of the question.

12,673, *Brotherton* (*Manufacturer*). Thinks that manufacturer should bear his fair burden of the extra cost to the authority of treating his effluent.

12,730, *Howard* (*Chemist, Vice-President, London Chamber of Commerce*). Opposed to any additional burden on manufacturers, who are extremely heavily rated.

12,812–4, *Davis* (*Manufacturer*). There should be a differential rate depending on the difficulty and expense of treating the particular effluent in each case.

12,905, *Reid* (*Vice-President of the Society of Chemical Industry*). Generally, not in favour of any additional burden on manufacturers.

12,937. *Marshall* (*Halifax Traders' Committee*). Generally speaking, manufacturers pay a large proportion of the rates, and, in manufacturing districts, provision should be made by the authority for treating the trade effluents. If it were found that manufacturers did not pay a fair proportion of the extra cost of treating the trade effluents, it would be fair and reasonable to impose a special rate to meet the excess.

13,680, *Tatton* (*Mersey and Irwell Joint Committee*). It seems fair that the manufacturer should be required to pay a special rate where his effluent goes into the sewers.

13,912, *Ellis* (*Tanner*). Yes, where character of effluent caused additional expense in treating the sewage.

14,049, *Wilson* (*West Riding of Yorkshire Rivers Board*). Generally agrees that special charge should be made.

14,199, *Whitaker* (*Bradford Dyers' Association*). No. Manufacturers are heavily rated, and therefore entitled to have their effluents dealt with by the local authority.

14,358, *Leech* (*Manchester Corporation*). Only in special cases where extra cost is incurred by the local authority.

14,371, *Dreyfus* (*Manchester Corporation*). No. It would be very injurious to trade.

15,868, *Mr. Phillips* (*Brewer*). Thinks it fair that a special charge should be made where trade effluent causes additional expense on local authority.

15,910, 15,926, *Mr. H. H. Waller* (*Vice-President of the West Riding District Councils' Association*). Thinks that power should be conferred on the local authority to make a special charge.

It appears that in some few cases manufacturers have by agreement with the local authority purchased the right to discharge crude trade effluents into the sewer.

27. The chief argument which has been used against a special charge being made is that a manufacturer who is heavily rated in respect of his premises is therefore entitled to the free use of the sewer.

This argument raises a general question of rating into which we do not propose to enter, but we may observe that other manufacturers producing little or no trade effluent are rated equally, and that, speaking generally, the amount of the trade effluent is not proportional to the rateable value of the premises.

Moreover, it has been stated in evidence that the amount paid in rates by the manufacturer would, in some cases, not be equal to the cost of treatment entailed on the local authority.

(Hirst (manufacturers), 10803; Foster (manufacturer), 11141-2; Sharpe (Otley), 12011, 12041; Davis (manufacturer), 12862; Wilson (West Riding Rivers Board), 14049.)

28. We have carefully considered this question from all points of view, and much may be said in support of the opinion that each manufacturer should be charged with the cost of the purification of his trade effluent.

We cannot, however, disregard the following considerations:—

(*a*) Under the existing law the local authority are not empowered to make a special charge.

(*b*) The evidence shows that, though it would be practicable were such a charge made, to ascertain what that charge should be, it would involve a very large amount of labour to settle the charge in respect of each manufactory.

(*c*) In the interests of the community it is desirable that most trade effluents should, subject to certain safeguards, enter the sewers and be purified by the local authority.

(*d*) In the interests of manufactures no new restrictions which are not essential should be imposed.

(*e*) A distinction ought to be made between the cases where the manufacturer complies with the regulations as to preliminary treatment, and the cases where he does not; and many important witnesses representing local authorities, including Sir Bosdin Leech and Alderman Dreyfus (Manchester), Mr. Hopkinson (Keighley), Mr. Jones (Pudsey), Mr. Beeley (Hyde), Mr. Platt (Rochdale), and Mr. Morgan (Bolton), have strongly expressed the view that no special charge should be made in the former class of cases.

29. Having regard to these considerations, we are of opinion that generally no special charge should be made on the manufacturer in those cases in which the regulations as to preliminary treatment are complied with.

As we have already stated, it is desirable that wherever practicable, some preliminary treatment should be carried out by the manufacturer.

But where the manufacturer is unable to comply with these regulations we consider that the local authority should be empowered to make a special charge.

Power should also be granted to make a special charge, even when preliminary treatment is adopted, where there are exceptional circumstances as regards volume, quality or otherwise.

30. We should leave the actual amount of the charges to be fixed by agreement between the manufacturer and the local authority.

In default of agreement the amount should be settled by a superior authority in the manner hereinafter explained.

31. In those cases in which a manufacturer is precluded from discharging his effluent into the sewer by reason of the fact that the water which he uses is obtained from a stream, and must therefore be returned to the stream, the duty of purification will still rest with him.

But we do not consider that this will be a serious grievance, as he obtains his water without charge, and this advantage may be set against the cost of purification.

Moreover it would be open to him to acquire the right to use the sewer by getting his water from some other source or by obtaining the necessary consents of riparian owners below him on the stream.

PROVISION FOR LOWERING THE CHARGE IN SPECIAL CASES.

32. At present a manufacturer discharging trade effluent into a stream can only be compelled to provide "the best practicable and reasonably available means" for purifying his trade effluent. Proceedings can only

be taken against him with the consent of the Local Government Board, and that Board are expressly precluded from giving their consent unless they are satisfied that no material injury will be inflicted on the interests of the industry by such proceedings. Rivers Pollution Prevention Act, 1876.

With this general principle we agree, and although we think that in most cases the additional cost of treatment thrown on the local authority by reason of the manufacturer not complying with the regulations as to preliminary treatment, or in consequence of the exceptional character of the trade effluent, would not be a serious burden on the manufacturer if exacted from him, we are of opinion that in cases where the local authority and manufacturer do not agree, and the case has to be settled by a superior authority, power should be vested in the superior authority to reduce the charge below the actual cost or to postpone it, in any case in which they are satisfied that the actual cost would be so great as to inflict a material injury on the manufacturer. In such a case the onus of proof should rest on the manufacturer.

We think that generally it would be in the interests of the community that a portion of the cost should be met out of rates rather than that either the pollution of the river should be allowed to continue or that the works should be closed.

PRESCRIPTIVE RIGHTS.

33. Many trade effluents already flow into sewers and are dealt with by the local authority.

In some cases these are first partially purified by the manufacturer, while in others they are subject to no preliminary treatment.

In regard to this point Dr. Maclean Wilson, the Chief Inspector of the West Riding Rivers Board, stated, "I think very strongly that the manufacturer will feel aggrieved, and justly so, if the law is not made applicable to cases of old connections, as well as to all cases of new connections," and other witnesses have expressed the same views. Wilson, 14057-14060. Platt, 12326. Davis, 12824-6.

34. We find that many of these old connections were made before the duty of purifying sewage was enforced on the local authority, and that some have been made without the knowledge of the local authority. Walker, 11310-12. Simpson, 11630. Sharpe, 12023-5. Platt, 12308.

We consider that all manufacturers should be placed on the same footing and that the proposals which we have made as to preliminary treatment by the manufacturer and as to a special charge being made upon him by the local authority in certain cases, should apply equally to the manufacturer whose trade effluent already passes into the sewer and to the manufacturer who is only proposing to obtain a connection. Mills, 11562. Wilson, 14,117.

35. In those few cases in which the manufacturer has by agreement with the local authority purchased the right to discharge trade effluent into the sewer the rights and position of the parties should, we conceive, be governed by the agreement.

36. Mr. Brotherton, M.P., urged upon us the importance of giving manufacturers reasonable time to carry out any requirements which may be imposed upon them. This consideration should, we think, have special weight in the case of existing connections. Brotherton, 12690.

ADDITIONS TO THE LAW.

BORROWING POWERS.

37. It appears that in some cases the borrowing powers of the local authority might not be sufficient to enable them to raise the loan necessary to defray the cost of enlarging or modifying their works so as to provide for trade effluents as well as ordinary sewage. King, 11505-8; 11513-7.

Such extensions of the borrowing powers as may be required for this purpose should, we think, be conferred on the local authority.

CONSTRUCTION OF TRADE SEWERS.

38. It may also sometimes be necessary for the local authority to construct a sewer for the reception of trade refuse alone and, in certain circumstances, it may be desirable that the local authority should provide a separate system of trade sewers, and also works for the partial treatment of trade effluents before they are mixed with the ordinary sewage for final purification.

Simpson (Halifax) 11670; 11,672. Sharpe (Otley) 12002.

If powers to construct such works are not already possessed by local authorities they should be conferred upon them.

SLUDGE REMOVAL FROM MANUFACTORIES.

39. The evidence shows that manufacturers would generally be willing to adopt reasonable means for the removal of solids from their effluent before passing it into the sewer.

It has, however, been represented to us that the disposal of these solids, which would be in the form known as sludge, is sometimes a serious difficulty to the manufacturer. At Salford the Corporation undertake the work of collecting and disposing of such sludge, and under the Public Health (London) Act, 1891, Section 33, the manufacturer is empowered to require the sanitary authority to remove any trade refuse from his premises, the manufacturer paying a reasonable sum for such removal.

King, 11549. Tatton, 13680.

We think it desirable that power to undertake the disposal of sludge at the expense of the manufacturer should be conferred on the local authority. We do not think, however, that the manufacturer should be empowered to compel such removal. If compulsion is necessary, this should be exercised by a superior authority in the manner hereinafter explained.

II. THE NEED OF SETTING UP A CENTRAL AUTHORITY.

The Settlement of Differences between Local Authorities and Manufacturers.

40. In an earlier section of this Report we have referred to the necessity of providing machinery for the settlement of differences between local authorities and manufacturers.

The chief questions upon which differences may arise are the following:—

1. The refusal of a local authority to allow a particular trade effluent to enter their sewers.
2. The refusal of a local authority to construct or enlarge sewers for the purpose of a particular manufactory.
3. The question of varying general regulations as to preliminary treatment by the manufacturer.
4. The amount of the special charge to be imposed on the manufacturer.
5. The removal of sludge.

41. We have taken a considerable amount of evidence as to the means which should be adopted for settling these differences. The following is a summary of the opinions which have been expressed to us:—

10,330-7, *Firth (Manufacturer)*. Complete confidence in the ordinary Courts of Law.

10,518-21, *Beaumont (Manufacturer)*. Central tribunal very desirable.

10,800-1, *Hirst (Manufacturer)*. Does not think special tribunal practicable.

10,839-40, *Bruce (Manufacturer)*. Ordinary Courts unsuitable. Suggests Rivers Board.

10,999-11,001, *Butterworth (Manufacturer)*. Central tribunal in very special cases. Would ordinarily prefer a Court or arbitration.

11,124-6, *Foster (Manufacturer)*. Supreme Rivers Authority would be a good plan.

11,282; 11,293, *Sheard (Manufacturer)*. Ordinary Court ruinous. Approved Central Rivers Authority.

11,363-6, *Walker (Manufacturer)*. Central Rivers Authority absolutely necessary.

11,700-3, *Walton, Simpson (representing Halifax Corporation)*. Central Rivers Authority preferable to Court of Law. Would not object to Local Rivers Board as a first tribunal.

11,809-16, *Jones (Pudsey District Council)*. Ordinary Court unsuitable. Suggests Local Rivers Board.

11,968-70, *Hopkinson* (*Keighley Corporation*). Prefers a Supreme Government Rivers Authority.

12,010; 12,062-12,065, *Sharpe* (*Otley District Council*). Central Government Authority desirable. Would save expense. Local Rivers Board would be thought by some to favour manufacturer.

12,077-8, *Powell* (*Handsworth District Council*). In favour of Central Government Board.

12,258; 12,265-7, *Beeley* (*Hyde Town Council*). Thinks ordinary Courts suffice. Would not object to appeal to Local Rivers Board.

12,342-6, *Platt* (*Rochdale*). Ordinary Courts unsatisfactory. Would prefer Central Board.

12,482-3, *Morgan* (*Bolton*). Central Government Rivers Board would greatly facilitate matters. Advantage to manufacturers and Local Authority.

12,587, *Johnson* (*Bradford*). Very great advantage to have Central Board for this and other matters connected with sewage disposal.

12,671–2, *A. E. Brotherton, M.P.* (*Manufacturer*). Central Government Rivers Board possessing requisite technical knowledge strongly recommended.

12,728–9, *Howard—Vice-President of London Chamber of Commerce* (*Manufacturer*). Decidedly in favour of highly specialised Central Authority. Thinks ordinary Courts unsuitable.

12,845–51, *Davis* (*Manufacturer*). Would prefer a Government Department having adequate technical knowledge. Local Rivers Board biassed in favour of Local Authority.

12,888; 12,907 *Reid* (*Chemist*), (*Vice-President of Society of Chemical Industry*). Ordinary Court most unsatisfactory. Special central tribunal a very great national advantage. Would be of great use also as advisory body. Money now wasted would pay expenses of a very expensive tribunal.

12,952, *Marshall* (*Halifax Traders' Committee*). Ordinary Courts suffice.

13,785–6; 13,788–9; 13801–2, *Tatton* (*Chief Inspector of Mersey and Irwell Joint Committee*). Local Rivers Board would be acceptable to all parties. Would allow an appeal from Local Rivers Board. No appeal would be necessary if Central Government Rivers Board were established. Would agree to establishment of Central Government Rivers Board, if it had complete expert knowledge, including a knowledge of all local difficulties.

13,881–2, *Dr. Squire* (*Society of Chemical Industry*). There should be a tribunal to which all difficulties could be referred. Suggests a special Court with permanent assessors or advisers.

13,912; 13,930-1; 13,928, *Mr. Ellis* (*Tanner*). Considers that a small tribunal should be established in each county to which all disputes should be referred. This body should contain representative business men and a paid representative of the County Council. Experts should also be retained. These might be at the service of more than one tribunal. Unwilling that the Local Watershed Board should be the tribunal.

14,048, 14,104, 14,105–6, 14,107–8, *Dr. Wilson* (*Chief Inspector, West Riding of Yorkshire Rivers Board*). A special tribunal would be advantageous. It should decide as to reasonableness of byelaws and conditions framed by local authorities, and whether, in certain cases, the conditions should be relaxed or made more stringent, and whether a money payment should be made. A much speedier and much less expensive tribunal than a Court of Law is necessary. Generally the Local Rivers Board would command the confidence of both parties as first Court of Appeal. Either Local Government Board or suggested Central Rivers Board would probably be acceptable as final Court of Appeal. Would prefer the Central Rivers Board as likely to be the speedier.

14,198, 14,322–3, 14,326–7, *Thorpe Whitaker* (*Dyers' Association*). Central tribunal unnecessary. Present methods of procedure are sufficient. The Local Rivers Board would not have their confidence.

14,357, 14,413–4, 14,417–9, *Sir B. T. Leech* (*Manchester*). An arbitrating central power would be of service; but a clearer definition of the rights and positions of authorities and manufacturers is wanted. Considers that the Local Rivers Board would have the confidence of both parties, and would be suitable as a first Court of Appeal. But would prefer a central body composed of experts and men with requisite legal knowledge; 14,422.

14,370, *Councillor Dreyfus* (*Manchester*); (14,378–9. *Sir B. T. Leech.*) A Central Government Rivers Board, composed of experts, would be preferable to any existing jurisdiction, provided, however, that it was speedy and inexpensive.

14,454, 14,458–9, *G. J. Fowler* (*Manchester*). Thinks it very advisable that a Central Board should be established, which would not only exercise power of inspection and control, such as Inspectors under Alkali Acts exercise, but would also act as an Advisory Board to which all local authorites and manufacturers could come for advice.

15,873–9, *Mr. Phillips* (*Brewer*). A central independent board should be constituted. Would agree to Local Rivers Board as a first Court of Appeal.

15,919, 15,927–34, *Mr. H. H. Waller* (*Vice-President of the West Riding District Councils' Association*). Ordinary Courts unsatisfactory and costly. Strongly in favour of a properly constituted Central Board. Agrees to Local Rivers Board as a first Court of Appeal.

EFFECT OF EVIDENCE.

42. It will be seen that the balance of opinion is strongly in favour of the view that for the settlement of these questions it is necessary to constitute a Central Board possessing adequate technical knowledge, such as the Supreme Rivers Authority which we recommended in our Interim Report. Some witnesses, while agreeing with this view, have expressed the

opinion that the questions should, in the first instance, be referred to the Local Rivers Board, and that the Central Board should be an appellate tribunal only.

Only a few witnesses consider that the questions can properly be determined by the ordinary Courts.

UNSUITABILITY OF LAW COURTS FOR THE DETERMINATION OF THESE QUESTIONS.

43. We have been struck by the large sums which have been expended in appeals to the Courts, but apart from the question of expense we are strongly of opinion that the ordinary Courts are not suitable for the determination of these questions; and we venture to think that the judgment of the Master of the Rolls in the case of Attorney-General *v.* Whitmore, to which we have already referred, clearly supports this view. His comment that "the evidence was very complicated, the expert witnesses who were called not only giving evidence quite inconsistent with one another, but some of them giving evidence in cross-examination which was quite inconsistent with what they said in examination in chief," might apply to many similar cases.

The scientific questions to be solved would in most instances be capable of actual determination by a properly-equipped Central Authority, and there can be little doubt that such direct proof would be far less costly than the process of endeavouring to arrive at the truth through the evidence of expert witnesses in a Court of Law.

Moreover, the matters to be determined include not only scientific questions on which witnesses may be expected to differ, but also considerations of an administrative character which should more properly be dealt with by a Government Department.

Further, we find that a Central Authority possessing adequate technical knowledge, would command the confidence of local authorities and manufacturers.

CENTRAL DEPARTMENT ESSENTIAL.

44. In our opinion a properly equipped Central Authority is essential, and we unhesitatingly recommend the creation of such an Authority.

In the interests of river purification as well as of the trade of the country we consider it is of the highest importance that the changes in the law which we have recommended should be made. But these changes would not in our opinion be of much use apart from the creation of a Central Authority for the determination of differences between the local authority and the manufacturer.

If the settlement of these differences be left to the ordinary Courts, differential treatment of manufacturers, with all the objections to it, will be certain to continue.

45. The Central Authority should have the following permanent chief officers:—

1. An Administrative Head.
2. A Bacteriologist having special knowledge of the bacteriology of sewage, trade effluents and water supply.
3. A Chemist having special knowledge of the chemistry of sewage, trade effluents and water supply.
4. An Engineer having a special knowledge of geology and water supply.

It should also be provided with a laboratory.

46. The officers of the Central Authority must be clothed with the necessary powers to conduct inquiries, to call witnesses, to enter premises to take samples of the trade effluent, and generally to do such acts as are necessary for the proper performance of their duties.

47. At any inquiries which may be held neither Counsel nor expert witnesses should be heard except with the special permission of the Central Authority.

48. The work of the Central Authority will be so intimately connected with the work of the Local Government Board that it will be desirable to make it a new department under the Local Government Board rather than an entirely separate department.

49. Certain witnesses expressed the fear that the decisions might be less speedy if the Authority were placed under the Local Government Board than they would be if an entirely separate department were constituted. This objection, however, does not seem to us to be valid. We can scarcely assume that the work will be regarded as less important, and therefore that the staff will be less adequate, merely because the Authority is attached to the Local Government Board.

50. We share the desire that differences which are referred to the Central Authority should be speedily dealt with, but it may be well to point out that some of the questions which will have to be determined cannot properly be decided without careful investigation, that at present a decision in the Law Courts is only arrived at after long and expensive proceedings, and that, although we think that much of the existing delay and expense will be avoided by the adoption of our recommendations, it will not be possible in all cases to arrive at speedy decisions.

It will be obvious, too, that at the commencement of the operation of the new scheme delays must needs arise which will subsequently be avoided.

RIVER BOARDS AS A FIRST TRIBUNAL OF APPEAL.

51. The following are the only Rivers Boards at present in existence:—

The Mersey and Irwell Joint Committee*, formed in 1891, and having jurisdiction over so much of the River Mersey and any tributary thereof, above the point of intersection by the southern boundary of the Borough of Warrington, as passes through the Counties of Lancaster and Chester, or between them, or through or by any of the County Boroughs of Bolton, Bury, Manchester, Oldham, Rochdale, Salford and Stockport.

The Ribble Joint Committee, formed in 1891, and having jurisdiction over so much of the River Ribble, and any tributary thereof, and of the Rivers Darwen and Douglas, and the streams running into the Crossens Channel, as passes through the County of Lancaster, or through or by the County Boroughs of Blackburn, Burnley, Preston and Wigan.

The West Riding Rivers Board,* formed in 1893, and having jurisdiction over so much of every river or tributary thereof as passes through or by the County of the West Riding of Yorkshire, and through or by any of the County Boroughs of Bradford, Halifax, Huddersfield, Leeds and Sheffield.

52. Under the Local Government Act, 1888, powers to enforce the provisions of the Rivers Pollution Prevention Act, 1876, were conferred on County Councils, and the Local Government Board were empowered to make provisional orders forming joint committees of County Councils and County Borough Councils for the exercise of these powers.

53. The three Rivers Boards are such joint committees. Previous commissions had urged that effective action for the prevention of the pollution of rivers could only be taken by dealing with the watershed as a whole, and the guiding principle in settling the area of jurisdiction of each Board was to place an entire watershed under one body.

54. We have received a large amount of evidence from the chief officers of the Rivers Boards as to their methods of work. We have also had many

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* The powers of the Mersey and Irwell Joint Committee and of the West Riding of Yorkshire Rivers Board were somewhat modified and enlarged by the Mersey and Irwell Joint Committee Act, 1892, and the West Riding of Yorkshire Rivers Act, 1894, respectively. The corresponding provisions of these Acts and of the Rivers Pollution Prevention Act, 1876, so far as they materially differ, are shown in a paper at the end of this Report. *See* Appendix B.

opportunities during our visits to various parts of the country of making ourselves personally acquainted with the operations of these bodies and we are satisfied that their work has been well done.

(R. A. Tatton (Chief Inspector to the Mersey and Irwell Joint Committee), 252-479; 13675-13876; F. Scudder (Chemist to same), 470-768; W. H. Wilson (Deputy Clerk and Solicitor to the Mersey and Irwell and Ribble Joint Committees), 769-798; W. Naylor (Chief Inspector to Ribble Joint Committee), 799-970; Trevor Edwards (Clerk and Solicitor to West Riding of Yorkshire Rivers Board), 977-991; Dr. Maclean Wilson (Chief Inspector of West Riding of Yorkshire Rivers Board), 992-1374; 14043-14138.)

55. As might be expected, some of those against whom action has been taken by Rivers Boards have complained. But we find that, generally speaking, both the local authorities and the manufacturers recognise that the Rivers Boards are taking effective action for the improvement of the rivers in their districts, and several witnesses have expressed confidence in these bodies as a first court to which differences between the local authority and the manufacturer might be referred.

56. In our opinion it is desirable that such differences should be settled by the Rivers Boards whenever this can be done, and, having regard to the valuable experience which these bodies have accumulated, to the fact that they represent large areas and possess capable officers, and to the confidence which they command, we think the following cases might very properly be referred to them in the first instance, power being given to either party to appeal to the Central Authority :—

1. Differences between the manufacturer and the local authority, as to variation of the general regulations respecting preliminary treatment to meet particular cases.
2. Differences as to the amount of the special charge to be imposed on the particular manufacturer.
3. Disputes as to whether the preliminary treatment adopted by the particular manufacturer complies with the regulations.
4. Differences as to the removal of sludge.

57. We think, however, at any rate for the present, that the following cases should be dealt with by the Central Authority alone :—

(*a*) Refusal of a local authority to allow a particular trade effluent to enter their sewers.

(*b*) Refusal of a local authority to construct or enlarge sewers for the purpose of a particular manufactory.

As regards (*a*) the difficulty would in most cases arise in consequence of the unusual nature of the effluent, and it is undesirable that each Rivers Board should be put to the expense of providing such a staff of skilled advisers as would be necessary to investigate such special problems as would be involved.

As regards (*b*) these complaints are already dealt with by the Local Government Board, so far as they relate to a failure of a local authority to provide sufficient sewers for ordinary requirements, and we think it is better to leave this matter entirely in the hands of the Central Authority.

Sec. 299 Public Health Act, 1875.

58. Differences arising in those parts of the country for which Rivers Boards have not yet been formed must, for the present, be referred to the Central Authority.

59. It will be seen, however, from the next section of this Report that we consider further Rivers Boards should be set up. The Central Authority should therefore be empowered to confer on the new Rivers Boards from time to time jurisdiction similar to that which we propose should at once be given to the existing Rivers Boards.

THE POLLUTION OF RIVERS AND THE PROTECTION OF SOURCES OF WATER SUPPLY.

60. At an early stage of our investigation we were struck by the fact that in many parts of England the pollution of rivers goes on unchecked, notwithstanding the fact that the Rivers Pollution Prevention Act has been

on the Statute Book for over a quarter of a century, and in our Interim Report we deemed it necessary to state that the protection of our rivers is a matter of such grave concern as to demand the creation of a Supreme Rivers Authority.

Since the issue of this Report we have been *requested by the President of the Local Government Board to make a recommendation dealing with the whole subject of water pollution.

61. The Central Authority, which we have recommended should be set up for the determination of differences between the local authorities and the manufacturers, should deal also with this matter. For this purpose it will be desirable to add an Epidemiologist to the staff of the Central Authority.

We do not, however, consider that the Central Authority should take the place of local bodies in regard to the protection of rivers and other sources of water supply. On the contrary, we think local power should be utilised to the fullest extent possible.

FORMATION OF RIVERS BOARDS THROUGHOUT THE COUNTRY.

62. In our opinion such power can only be fully utilised by the formation of Rivers Boards throughout the country, and we therefore recommend that such Boards should be formed.

63. Although the Rivers Boards are merely joint Committees of †County Councils, and therefore only possess for the combined areas the same powers which the individual Councils might have exercised in their respective districts, we are satisfied that such combinations are of much greater value for the protection of rivers and streams than the separate Councils acting independently.

64. In the first place, they are bodies expressly created for enforcing the provisions of the Rivers Pollution Prevention Act, whereas the separate County Council is under no obligation to enforce these provisions. And we find as a fact that in many counties outside the areas represented by the existing Rivers Boards little or nothing is done by the County Council to exercise its powers of checking river pollution.

65. Then, too, a Rivers Board has jurisdiction over practically the whole of a watershed. This is a point of considerable importance.

It has been again and again pointed out by previous Commissions that to obtain effective action there should be some one authority with power to deal in each instance with the whole watershed, and we entirely concur in this view.

66. Another advantage of combination is that the area under the jurisdiction of a Rivers Board is sufficiently large to secure the appointment of skilled officers.

67. We have not sufficient information to enable us to say what precise combinations should be made. Each Rivers Board district should however include, as far as practicable, the whole of one or more watersheds, and it should be sufficiently large to justify the permanent appointment of a skilled Chief Inspector at an adequate salary.

One of the first duties of the Central Authority will be to ascertain what grouping of counties would be most effective, and then to take steps to constitute Rivers Boards for these areas.

DUTIES OF RIVERS BOARDS.

68. We have found in the course of our inquiry that water supplies are liable to other serious pollutions besides those which can be dealt with under the Rivers Pollution Prevention Act, and although in the case of the

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* See letter of the 7th January, 1903, at end of this Report. Appendix A.

† Under the Local Government Act, 1888, the Council of a County Borough is for this purpose a County Council.

larger water undertakings the owners may be desirous of doing all that is possible to safeguard their sources of supply, we are satisfied that there are cases where the supervision of some superior authority is desirable in the interests of public health.

Such supervision could, we think, be usefully carried out by the Rivers Boards, and we therefore recommend that, in addition to the duties which these bodies will possess under the existing law in regard to pollution of rivers and streams, it should also be their duty to inspect public water supplies and to report to the Central Authority any cases of dangerous pollution of such supplies which they may detect.

69. The Chief Inspector of each Rivers Board should be required to make an annual report on the work of each year, and copies of these Reports should be supplied to the Central Authority.

FUNCTIONS OF CENTRAL AUTHORITY.

70. The Central Authority should exercise a general superintendence over the whole country in regard to the prevention of pollution of water. They should direct any inquiries or investigations which they may consider desirable, and generally they should stimulate and encourage Rivers Boards to an active exercise of their powers.

71. As regards dangerous pollutions of public water supplies it should be the duty of the Central Authority to investigate cases brought to their notice by the Rivers Boards, and in any case in which they are satisfied that the conditions are such as to render the supply dangerous to health they should bring the facts to the notice of the Company or Local Authority which is supplying the water.

72. We should hope that this would usually suffice and that the supplying authority would willingly take such steps as might be necessary to remove the danger.

But it is perhaps necessary to provide for other cases, and we therefore recommend that the Central Authority should be empowered, after local inquiry, to order the purveyors of the water, or other responsible parties, to adopt such means as in the opinion of the Central Authority are reasonable and necessary for removing or diminishing the danger.

Such orders should be enforceable by mandamus.

73. Power to enter at all times gathering grounds and waterworks and to take samples of water should be conferred on the officers of the Rivers Boards and of the Central Authority.

WASTE OF WATER AND ABSTRACTION OF WATER FROM ONE DISTRICT FOR DISTRIBUTION IN ANOTHER.

74. In regard to the further questions which are referred to by the President of the Local Government Board it appears to us that the Central Authority might, with the aid of the Rivers Boards, very properly collect such information as is available throughout the country in regard to waste of water by pumping from mines, and in regard to the abstraction of water from one district, for the supply of another district, to the detriment of the water supply of the district from which the water is taken.

75. We entirely agree that the collection of such information should precede the consideration of the question whether legislative interference in regard to these matters is desirable.

SCOTLAND AND IRELAND.

76. The adaptation of the recommendations made in this Report to the legal, administrative, and other conditions of Scotland and Ireland is reserved for further consideration.

GENERAL POSITION OF OUR INQUIRY.

77. In conclusion, we think it may be desirable briefly to explain the position of our investigations.

78. At the commencement of our inquiry we devoted considerable attention to general questions relating to the chemical and bacteriological analysis of sewage and sewage effluents.

The methods of bacteriological analysis which we have adopted are explained in a paper by Dr. Houston, which we presented with our Second Report.

A paper is now in preparation by Dr. McGowan in regard to chemical analysis, which will contain a detailed account of the work which has been done under our direction, with a view of settling the value of different methods of analysing sewage effluents.

79. We have completed a systematic investigation of the land treatment of sewage on farms of different kinds of soil.

This investigation has extended over a period of two years and has embraced the bacteriological, chemical and engineering aspects of this method of disposing of sewage.

80. We are now making a similar investigation of artificial processes of various kinds at about thirty distinct places. This investigation will, we hope, be completed in about a year.

In addition certain authorities are, in conjunction with us, making similar systematic observations in regard to a number of artificial processes.

When these results have been collected, we shall endeavour, in compliance with the instructions contained in the second part of our Terms of Reference, to report on the different methods of treating sewage in the same and in dissimilar sets of circumstances.

81. In the meantime, we are taking evidence as to the discharge of sewage, sewage effluents, and manufacturing effluents into tidal waters. The importance of this subject as regards the contamination of shellfish has recently come into prominence. It is indeed a matter of great importance from the point of view both of public health and the fishing industries.

82. We are also continuing the investigations which we referred to in our Interim Report, for the purpose of ascertaining whether it is practicable to destroy those micro-organisms which are common to sewage effluents, and which may be dangerous, if the effluent flows into a river from which water for drinking is obtained, and we are generally considering what measures may be desirable to lessen dangers so arising.

83. Subsequently we propose to consider the methods available for the satisfactory disposal of manufacturing effluents when not mixed with ordinary sewage.

(Signed) IDDESLEIGH, Chairman.
C. PHIPPS CAREY.
M. FOSTER.
T. WALTER HARDING.
WILLIAM RAMSAY.
JAS. B. RUSSELL.
W. H. POWER.
T. J. STAFFORD.

F. J. WILLIS, Secretary.
2nd March, 1903.

APPENDIX A.

LETTER from the Local Government Board, dated 7th of January, 1903.

Local Government Board,
Whitehall, S.W,
Sir, 7th January, 1903.

I AM directed by the Local Government Board to state that they have had under consideration the request that they should furnish the Royal Commission on Sewage Disposal with certain particulars and information in connection with the deputation which the President received recently on the subject of water supplies and pollution, and I am accordingly to forward the accompanying copy of a Report of the proceedings on that occasion and of a Memorandum prepared by the County Councils Association on the subject. The Report is being printed, and as soon as the copies are received 12 of them will be forwarded.

As regards the pollution of rivers and other sources of water supply, which was one of the three questions raised by the deputation, it will be observed that the President stated in reply that the Royal Commission were inquiring into pollution from sewage and other causes, and suggested whether the terms of the reference to them were not wide enough to enable them to inquire into the whole subject of pollution of water supplies. Mr. Long would be glad to be informed of the views of the Commission on this point.

Mr. Long does not know whether the recommendation of the Commission in their Interim Report as to the constitution of a Supreme River Authority, was intended to apply only to rivers or also to other sources of supply, but it seems to him that it would be very convenient if the Commission could make some recommendation dealing with the whole subject.

Two other questions were raised by the deputation:

(1) The taking of water for sale outside the area of the supplying authority to the detriment of local interests in the areas from which it is taken; and

(2) The waste of water.

On these questions the President does not at present possess very definite information; but it has been suggested that if a Supreme River Authority is created that body might with the aid of the Watershed Boards which the President understands are contemplated by the Commission, obtain full information throughout the country on these matters. Such information would be most useful in assisting him to form an opinion on the question whether it is desirable that Government control of water supplies should be instituted.

The President would be much obliged therefore if the Commission would consider this question also, and furnish him with their observations thereon.

I am, Sir,
Your obedient Servant,
John Lithiby.
Assistant Secretary.

The Secretary,
Royal Commission on Sewage Disposal,
39, Victoria Street, S.W.

ENCLOSURES to the Letter from the Local Government Board dated 7th of January, 1903.

Grand Committee Room, Westminster Hall,
Wednesday, 29th October 1902.

PROTECTION OF WATER SUPPLIES.

DEPUTATION to the Right Hon. WALTER HUME LONG, M.P., President of the Local Government Board, &c., &c., from The County Councils Association, The Sanitary Institute, The British Association of Waterworks Engineers, and The Underground Water Preservation Association.

The President was accompanied by:—Sir S. B. Provis, K.C.B. (Permanent Secretary); Mr. J. Lithiby (Assistant Secretary); Mr. Herbert E. Boyce; Mr. W. H. Power, F.R.S. (Medical Officer); Mr. A. B. Lowry (Private Secretary).

The Deputation consisted of the following:—*County Councils Association:* The Right Hon. Sir John E. Dorington, M.P., Chairman Gloucestershire County Council; the Right Hon. T. F. Halsey, M.P., Vice-Chairman Hertfordshire County Council; Mr. E. J. Halsey, Chairman Surrey County Council; Mr. H. Hobhouse, M.P., Vice-Chairman Somerset County Council; Mr. J. H. Johnstone, M. P., West Sussex County Council; Mr. M. F. Blakiston, Clerk, Staffordshire County Council; Mr. H. E. Clare, Clerk, Lancashire County Council; Mr. W. J. Freer, Clerk, Leicestershire County Council; Mr. C. E. Longmore, Clerk, Hertfordshire County Council; Mr. G. Montagu Harris (Secretary). *Sanitary Institute:* Sir Alexander Binnie; Mr. A. Wynter Blyth (Chairman); Major R. H. Firth; Mr. William Whitaker, F.R.S., F.G.S.; Mr. J. E. Worth, London County Council; Mr. E. White Wallis, F.S.S. (Secretary). *British Association of Waterworks Engineers:* Mr. W. Matthews; Mr. R. E. Middleton, M.Inst.C.E.; Mr. C. H. Priestly; Mr. Percy Griffith (Secretary). *Underground Water Preservation Association:* Mr. William May; Mr. Clayton Beadle (Secretary). Lord Edmund Fitzmaurice; Mr. Humphreys-Owen, M.P.

Mr. Heywood Johnstone, M.P.—Sir, I have to introduce to you this afternoon a Joint Deputation from the County Councils Association, the British Association of Waterworks Engineers, the Sanitary Institute, and the Underground Water Preservation Association, four bodies whose names shall be handed to you, as also the names of the gentlemen representing them on this occasion. We desire in the terms of a Memorandum prepared by a Committee of the County Councils Association, and adopted by the County Councils Association as a whole, which Memorandum I think has been before you, to call your attention to the "question of the protection of sources of water supply in England and Wales and to the pressing necessity for an inquiry into the existing state of the law on the subject. In so doing they proceed on the assumption—firstly, that the question is one of great and increasing importance to the community at large; and secondly, that the laws governing it are defective and faulty." I need not call your attention at any great length to this Memorandum, but I should like to point out to you one illustration on page 2, which shows the nature of the case which does arise from time to time, and especially ought to be guarded against in the public interests, and that is, that certain districts supplied by a local Water Company found themselves in danger of losing that water supply from the operation of a Waterworks Company which purchased a small area of land within the area of the local body, proceeded there or intended—I do not think they got so far—but they contemplated sinking a well there, and arranged with a Railway Company to carry their pipes along the line, and they would probably have been able to pump the whole district very nearly dry to carry the water to their own profit and to carry it somewhere else far away from its source. It is not an isolated instance, and to account for my own presence here I may say that my attention has been recently drawn to exactly the same sort of thing in my own constituency, where a small and somewhat indigent local authortiy having at considerable expense an excellent and very necessary supply for its people, now find themselves in danger of being deprived of that supply by the members of a body which was going to build a hospital and sink a very deep well, and in all probability carry off the water supply of the local authority within whose neighbourhood they were, but they came to terms. As to the existing state of the law there is no protection for underground water which cannot be proved to flow in some definite and known channel.

As to the Memorandum dealing with legislation, I may say that I am a Member of the Court of Referees and the subject has been frequently brought to my notice from the

hardship which occasionally arises from persons whose water supply is very greatly threatened having no *locus standi* before private Committees of the House. Of course that only refers to the case where Parliamentary powers are required at all; where local Parliamentary powers are not required the local authorities are absolutely helpless, and the pumping of underground sources of water supply goes on. It is only during the two last Sessions, I think, that the House has given even a discretionary power to the Court of Referees to allow persons whose water supply is threatened in this way to appear and be heard before Committees. I know a case which came under my own observation in the Court where the Corporation desired to purchase a farm and to sink wells thereon, and to supply their own people at considerable distance. Where this farm was situate there were adjoining farms belonging to an owner—whose name I do not mention—who would have been certainly in danger of being deprived altogether of their water supply or else they would have had to pump it at a very much greater cost, and apart from the special powers to give him a *locus standi* the owner was fortunately in a position to take action, or he would have been helpless and would have been obliged to stand by and see the source of his water supply either very seriously impaired or else altogether taken away.

I will now call upon the different speakers who have been appointed to address you to set forth their views from their particular point of view, and having heard them you will be able to say whether you can accede to their request, and after due consideration we hope you will see your way to urge upon His Majesty's Government the desirability of appointing a Royal Commission to investigate a matter of so much importance and so much difficulty, and upon which the state of the law at the present time is so uncertain and indeed so unsatisfactory.

Mr. Halsey, who appears for the Surrey County Council and as representing the County Councils Association, will now address you.

Mr. E. J. Halsey.—I am very much obliged to Mr. Heywood Johnstone for having put this matter before you so much better than I can myself, perhaps. He spoke with reference to this particular question upon this Memorandum, page 2, with reference to the larger water company very nearly swallowing up the smaller one, and it is that case which caused me to take up the matter before the County Councils Association three years ago and which I felt was a very serious one and might be repeated elsewhere and against which there was no remedy.

I should like to say at once that I come before you, representing the County Councils Association, with no suggested remedy, with no scheme as to what authority or who is to have the jurisdiction over the supplies of this country, but simply to request that the whole of the evidence may be put before a Royal Commission and an authoritative opinion given which, we hope, might reconcile the different views of parties that are interested in this matter. I say that at once because the County Councils Association did assay a draft Act of Parliament as a remedy for this matter, but they very soon found that in this water question, as is the case in a good many different things, it would be absolutely impossible to try and force their opinions until really proper investigation should have taken place on the whole subject. We were influenced a great deal by what other people told us in this matter. You will hear presently from the British Association of Waterworks Engineers that in June, 1899, they passed a resolution that the water supply is a subject of national importance and ought to be under national control or supervision. They are an important body and would not have passed a resolution of that kind without going into the question thoroughly.

I notice that the Institute of Public Health met at Exeter in August of this year, the Earl of Iddesleigh in the chair, and in the course of his opening address, said, *inter alia*, as follows:—"Another subject of great importance was that of the use and abuse of our water supplies. If he were an absolute emperor he should appoint a department of the Government to deal solely with water administration. He should expect that department to prove beneficial to the community by the wise exercise of its discretionary powers and, to a greater degree, by reason of the knowledge which it would slowly accumulate and place at the disposal of the country. One simply could not exaggerate the vital consequences of exact knowledge concerning water supplies, either in respect of health or wealth."

In an Inquiry recently in Surrey, the Duke of Northumberland wrote:—"I am strongly of opinion that the whole question of water supply all over the country should be thoroughly gone into by a Royal Commission or something of that sort; and the way in which we are conducting a happy-go-lucky scramble for water is most undesirable; but until some inquiry is held I fear there is nothing for it but to do the best we can."

That is an important evidence of the difficulty of dealing with this question. As you are aware, the Duke of Northumberland has large properties in Surrey and elsewhere and he has experienced very great difficulties and so have the local bodies also. It is not only a question of the supply of water being sufficient for the nation at large or regulating the sources of supply, but it is also necessary in connection with that to regulate to a certain extent the use of water, that is to say, to avoid that terrible waste that is going on in certain districts of this country. That is all set out in this Memorandum, and the enormous waste of waters in some of the pits in the Midland counties and elsewhere where, instead of tubbing every shaft as they used to do, they find it more economical to let the water run to waste, thereby making material difference to the water supply of the neighbouring districts. There is an immense quantity of water running to waste, and it is also an undoubted fact that there are many parts of the country where the supply of water is barely sufficient and where the economical and judicious use of machinery to prevent waste would be of the greatest possible advantage.

I think when you have heard the evidence of gentlemen who are very much more expert and capable of forming an opinion upon such a matter as this than we of the County Councils Association, that when you find us joining them, knowing the different interests of our own various localities, and when we are all of one opinion that a definite inquiry is necessary, you will admit that the case is strong, at any rate; whether it is sufficiently strong for the Government to grant what we wish is another question. But it is a strong one and it is almost entering into our daily life in the country and we should be glad to see a satisfactory solution of it.

Of course, in connection with the water supply there are other matters, such as the question of pollution and the necessity of pure water and water for sanitary purposes. Upon that subject another gentleman will speak, but I would like to point out that if there is no water there can be no pollution of water. What we want is enough water, and having got enough we think it should be served pure and bright to everybody.

Of course there is this great question of the private right of water which will be referred to the Commission to consider, I assume. It is emphasised by what Mr. Heywood Johnstone has said, and it is perfectly well known that this right of private water as decided by law makes the question a much more difficult one. It will have shortly to be decided as to whether that is to remain the law or whether the law is to be altered for the benefit of the public at large without detriment to the private owner as regards his own private property.

Then the question of the supply of water to the manufacturers and so on—in fact it is so broad that if one desired to go into it it would occupy too long a time. What I have said, and what other speakers will say to you, will be sufficient to recommend to your colleagues that this matter is of vital importance to the country and the sooner it is taken in hand by a Royal Commission the better; because meantime the water supplies of this country are being for some reason or other—there are different reasons why—rapidly depleted, and difficulties are arising frequently through many districts with reference to that matter. I leave it in the hands of gentlemen more competent to deal with it than myself.

Mr. Percy Griffiths.—Sir, I have been asked as Secretary of the British Association of Waterworks Engineers to take this matter up. It was thought by the members that I could lay this matter before you being conversant with the facts. Our Association was formed in 1896 and among the objects for which it was formed were the following:—Assisting the Legislature, public bodies, and others, in ascertaining the views of those interested in waterworks undertakings, and originating and promoting improvements in the law relating to waterworks. We are therefore appearing strictly in accordance with the objects of our institution. The position of the Association is that it is representative of the waterworks engineers not only of this country but of the Colonies. This subject which is now brought before you was taken in hand as early as June, 1899, a very few years after the Association was formed. I mention that to indicate the fact that as soon as the water engineers formed themselves into an Associa-

tion their attention was brought to this question at once and I suggest that as a proof of its urgency. At that meeting a resolution was passed which was sent to you and I have no doubt has received your attention. Various points were dealt with in it which I think I need not refer to or take up your further time with; but the broad lines were that some alteration was required in the waterworks of this country. The matter was then allowed to drop. A Committee was formed to continue the subject with a view to further action being taken thereon. This Committee reported to the Council in November 1900, and their report was submitted to a general meeting of the members on December 8th, 1900, when it was duly adopted and ordered to be printed and circulated. This document has also no doubt been brought to your notice, but it will be perhaps advisable for me to summarise the substance of it, as it forms the main ground for our appearance before you to-day. It is divided into seven heads with remarks attached to each as follows: (1) The present system of control over undertakings for public water supply is unsatisfactory. After pointing out the difficulty and expense involved by the distribution of the chief control between the two Houses of Parliament, the Board of Trade, and your own Honourable Board, the report suggests that the procedure in connection with water schemes could be greatly simplified and cheapened, and that the decision of the supreme authorities would be rendered more uniform if all points of policy were referred to a new single authority and points of detail and engineering dealt with by independent experts. A further suggestion is made that in order to secure a proper public water supply in some rural districts assistance should be afforded by the wealtheir towns in the immediate neighbourhood. (2) The existing powers for enforcing a proper water supply are inadequate. Under this head attention is called to the difficulty in effectually fixing the responsibility for affording a water supply to any district upon any person or body, and to the fact that so many rural districts are at present without a proper supply, and without any practical supervision of what supply there is. (3) The areas allotted to existing local authorities are altogether independent of the sources of water supply. In this connection it is pointed out that the limits of existing sanitary districts are often very inconvenient with respect to the supply of water, and that the existing facilities for joint action with regard to any particular sources are inadequate and unnecessarily costly. This is no doubt the most important ground on which His Majesty's Government are asked to take action. Our Association does not necessarily agree with the suggestion of the Sanitary Institute (also represented to-day) that the districts of sanitary and water authorities should in every case be co-terminous, but we do feel that the existing haphazard manner in which the limits of water authorities are fixed (particularly in the allocation of different sources of supply) is extremely unsatisfactory. (4) The law relating to underground water is inequitable and a standing danger to many public water supplies. This is a point which the County Councils Association are taking up more fully than our Association, but our position is briefly this: that some means should if possible be found to prevent the sources of existing public supplies being interfered with. (5) The law relating to pollution of water requires revision. This is a question with many bearings, among which may be mentioned (*a*) the pollution of supplies at the source (that is before use); (*b*) the pollution of water in course of pumping, filtering, storage or distribution; (*c*) the detection of such pollution in time to prevent the use of such water by the consumers; and (*d*) the prevention of pollution under all conditions. At the present time the law provides no certain means either of detecting or preventing pollution, neither does it provide any effective penalty for the supply of polluted water and consequent loss of life. It is not of course suggested that any legal restriction could adequately cover all the points involved under this head, but it is respectfully urged that some provision should be made to fix the responsibility for periodical examination, and, where necessary, interference to prevent the recurrence of such disasters as befell the towns of Maidstone, King's Lynn and Worthing in recent years. (6) The Provisions for preventing waste are insufficient. The existing provisions for regulating the use of water and preventing waste are so diverse, and in many cases so ineffective, that we consider the general law urgently requires consolidation and revision with a view to the reduction of waste generally. As water must in most cases be dealt with a second time in the form of sewage, thus involving double expense, we suggest that the remedy of existing evils in this respect would effect a considerable economy to all consumers and ratepayers concerned. (7) The collection and publication of official returns relating to existing undertakings is much to be desired. Our Association has already taken steps towards this end by an endeavour to collect statistics of all the water undertakings in this country of a more comprehensive nature than any previously obtained, but it is obvious that a complete return is impossible except under Government compulsion or authority such as applies to gas undertakings. There can be no doubt that such returns would be of enormous value in dealing with questions of water supply generally. The last part of the report is with reference to official returns. Beyond the points raised in this report there are many others which have been subject to discussion by our committee. Some of these are matters of detail which must inevitably arise in any consideration of the question as a whole, but two are of sufficient importance to warrant special mention:—(1) The relations existing at the present time between local authorities and water companies, whether as competitors for ownership of the public supply of water or otherwise, are very unsatisfactory. The existing law appears to involve much friction and expense which might be prevented by a more definite enunciation of the powers and responsibilities of the contending parties. As our Association is representative of both company and local authority undertakings we have no direct interest in the question as to which system is preferable, but we do feel that the present condition of affairs is the cause of serious interference with the practical efficiency of many existing undertakings and the cause of much needless delay in the supply of water to towns and districts at present without a proper public supply. (2) The other point we desire to bring before your notice is that the existing general waterworks law urgently requires consolidation, and private bill legislation should be rendered more uniform than it is at present. Local authorities administering the public water supply are governed by at least six General Acts and many have Provisional Orders of your Honourable Board or Private Acts of Parliament containing very divergent provisions. Many companies' undertakings and those owned by private individuals are under no Parliamentary control whatever, others are governed by Provisional Orders of the Board of Trade incorporating three General Water Acts and a large number of Companies' Acts, and others again by Special Acts incorporating three General Acts but containing extremely divergent provisions as to general responsibility and management. In conclusion I am directd to urge that upon the grounds stated there exists urgent necessity for the appointment of a Royal Commission or Parliamentary Committee of Inquiry to deal with the question of water supply throughout this country.

Mr. Matthews (*Past President, British Association of Waterworks Engineers*).—Sir, on the question of legislation, taking one point it is to our mind in this position: The Waterworks Clauses Acts of 1847 and 1863 on the preamble stated that, owing to certain clauses having in recent years been put into a number of Acts of Parliament, the time had come when they should be consolidated into a General Act. Our point in connection with legislation is that it has in recent years become so necessary to put model clauses into practically every local Act on Water Supply which is brought in that the same state of things is existing now, and that these various clauses and others which after consideration might be deemed desirable should be put into a General Act. Unfortunately some of the clauses of the Public Health Act of 1875, and the clauses in the Waterworks Clauses Acts of 1847 and 1863, are quite inconsistent with one another, and therefore revision is necessary there.

As to the question of conrol, as to which Mr. Halsey made some remarks, it is a fact that at the present time the amount of control which can be exercised over the water supply is exceedingly limited; there are no powers by a local sanitary authority over the property of any water company or of any sanitary authority which might be supplied. It is also a fact on the cases or authorities under similar conditions given by most of their local Acts they can acquire certain lands by agreement, and having acquired those lands by agreement they can put up works subject to no control whatever. They are not

obliged to go to Parliament or to your Board for sanction to carry out the works, which works might be good, bad or indifferent, and the consequence is that certain works (? are executed) which had they been brought under the control of Parliament or your Board, would never have been sanctioned or carried out. Then afterwards there is no supervision, even though works may be carried out with the sanction of Parliamnet or of your Board, those works having been sanctioned provided they are within the limits of deviation there is no supervision afterwards to see that the spirit of the Act has been carried out properly. Your Board gives sanction to carry out a certain water supply. You have no power to say, "This has not been carried out according to the proper conditions, and we will have the work done over again."

Then with regard to what is to be the hereafter of the water supply. We offer no expression of opinion as to what should be the constitution of any Board or Boards which shall take up the question, but we do say that the existing state of things is purely parochial and that the question of water supply is far beyond the parochial question and should not be left in the position in which it now is, but that some authority which has not the same purely financial control in the thing should have some say in the question of how and in what manner these things shall be carried on.

Those are the principal points which we urge upon you—that it is actually necessary that some investigation shall be made as to how far the existing state of things is not satisfactory.

The last Commission which dealt with the question of water supply in the country generally, of course apart from the Metropolis, a question we do not refer to, the last general Royal Commission which sat to investigate the question of water supply in this country was as far back as 1866 or 1867, presided over by his Grace the Duke of Richmond and Gordon; and it goes without saying that an enormous advance has been made in the way of water supply from that date which warrants the Association in thinking that the time must arise when a particular revision of the whole question underlying such a large subject as that should be brought up again.

Mr. W. Whitaker.—Sir, I need hardly say that the Sanitary Institute consists of members who have diverse interests and very various opinions. We therefore, in a question of this sort, take no side and enter into no controversy. We only wish to put forward considerations which are believed to be for the national good apart from all mere local questions. In enforcing that I should wish to lay particular stress, almost the only stress, upon purely sanitary matters, but in order to do that properly I must allude in the first place to some general considerations.

The first of these is that we should ask that if such an inquiry should be granted that it should be a thorough one; that it should take up all sides of the question and not be limited to any one particular part of the subject. I would say that it should not be limited to public supplies; it should also consider private supplies. I do not mean, of course, mere house supply or anything of that sort, but there are places in which large estates have what may be called a semi-public supply. In any investigation of this sort we think that all these schemes should be considered and reported upon as much as public supplies. Besides these of course there are in some places very large what we may call trade supplies; there are trades in which the supply of pure water is absolutely essential, sometimes in small quantity and sometimes in large; at any rate, there are very many trades in which a large quantity of water must be used. We think that the investigation should include those supplies also, so that we may know in any given area what the whole of the supplies are, and not merely those used for public purposes.

Besides that there is another matter—it is not a question of supply—it is a question of water extraction. One part of that has been alluded to by Mr. Halsey. In our coal districts very often it happens that a large supply of good water is pumped to waste. We think that the inquiry should certainly include such subjects as the pumping of water to waste, and it is not only in mining countries that this happens; it occurs also to a very large extent where quarrying is going on. I have heard of a case where several millions of gallons per day of water—of presumably good water—being very much the same as used for the public supply—that a large quantity is pumped out of a quarry in order that more stone or what not may be got. We think that the inquiry should take in all these circumstances as well. There are public works, such as millers, brewers, engineering works, in which it is essential sometimes that a large amonut of water should be pumped; and there is a case, a fairly well-known case, where something like 15 millions per day is pumped, and pumped to waste, and I am informed that it does not improve some of the neighbouring wells in their yield. We think that these yields should be a matter of inquiry as well.

Then coming to the more sanitary aspect of it, which, as I say, cannot be thoroughly entered into without these other questions, and I will give an illustration of that: We know of a case of large engineering works where water is pumped out, and that water is not only fresh water but salt water which is pumped in from a neighbouring estuary. The result of that probably is that the salt water goes beyond that area of pumping, and it is possible that it may affect neighbouring wells on the way, not by taking their water simply, but of supplying it with salt water or partly so. Those are things for inquiry.

Then coming to the worst aspect that has been alluded to, we think there should be protection for water supplies, largely, of course, protection from interference with other folk seeking supplies, that there should be some protection in quantity; but we, as sanitarians, are largely concerned in the protection of quality. As things are at present it is quite open to anyone to supply the neighbouring water company very easily. I heard of a case a little time ago where some wells were got rid of to go into a sewage scheme, and not particularly far off waterworks. There are many cases of this contamination, whether from sewers, cemeteries, or trade waste. There are questions as to the distance they are efficacious for harm, and very diverse opinions are held. We think that these particulars should form one of the subjects of the Inquiry which we ask you to establish. We know a case—it is a risk very often of a water authority who knows that their supply has a risk of contamination, they are perfectly willing to put it right and perfectly willing to go to some expense to safeguard their supply, and they are met with legal and other difficulties which really are very trying. That certainly is not a sort of thing that ought to be. If you have a company or authority who is willing and agree to do the best it can to protect its water from evil, it should not be discouraged but rather encouraged in so doing. At present the balance is rather in favour of discouragement. We ask simply for an inquiry as to the fact, an inquiry which, when this fact was well established, should be followed by a suggestion for legislation. We ask for this inquiry so that water may be used in the best possible way in the future and with the least possible damage to all interests, public and private.

Mr. William May.—The Underground Water Preservation Association was formed in the early part of this year owing to the sources of water, principally in West Kent, becoming practically arrested. The association was formed by many noblemen, and gentlemen, and mill-owners, and brewers, and tradesmen, who were all affected by the drying up of the streams. Since this Association was formed investigation has been made, and the facts that the Association has ascertained are clearly first that the streams in West Kent have in several instances ceased to exist. I could enumerate at least five. It was said that they had ceased to exist because the rainfall had not been kept up; but we have gone very systematically into the rainfall question and we are satisfied that if the rainfall had been kept up to the average there was not enough rainfall to fill up the vacuum caused by the water that has been abstracted. We have not gone thoroughly into the matter, but we have obtained the best advice that we could possbily have, we have had it statistically before us, and we are satisfied that the depletion of the water, principally in West Kent, is a most serious matter. Not only is it serious to manufacturers, brewers, and others who are dependent on a large source of water for their business, but it is most important from, I may say, the agricultural point of view. We collected evidence that large, old, standard wells, that had possibly been in existence for 100 or 200 years, were drying. We also ascertained the fact that when we had samples several feet below the soil—where it used to be in former times full of water—it was as dry, as one man said, as a turnpike road. The fact is that the rainfall is so at once taken up that there is nothing left for the surface.

Then, again, we have had the difficulty in the sanitary point of view of our streams having dried; we come into this position: what are we to do with them, being dried

up? They are simply sources of great pollution. We call upon the riparian owners to cover places in, but what are we to do? It is a matter the County Council of Kent have taken up, and they are considering it to be a most important question.

We have also ascertained that although we believe there is the most abundant supply of water at the present moment at the mouths of the rivers, yet we know as a fact in Essex that they can only pump a few hours per diem, because if they pump more in comes the brackish water, and there is no reason whatever to suppose that these pumping stations at the mouths of rivers can be used in the same way as if they were pumping from an inexhaustible supply.

The Association of Underground Water Preservation has ascertained without the slightest doubt that what is called the underground basin, or the Thames basin, is being exhausted of its water, and it only requires a few more years and the extension of pumping to go on when that water will cease.

REPLY.

The President.—I am very much obliged to you for putting the case before me as clearly as you have done. I think there is no dispute, certainly among people who have had to look into this question, as to the gravity of the case which you have put before me to-day, or, indeed, as to the main facts which have been described here. We have had abundant evidence of the very worst pollutions of our water supplies in different parts of the country, and there has also been abundant evidence of the fact to which reference has been made by nearly every speaker, that frequently water is abstracted for what I may term a limited use which ought to be available for more general use in the neighbourhood to which it belongs.

The three questions which you have been good enough to bring before me to-day are pollution, waste, and what I may describe, generally speaking, as water rights.

With regard to pollution, as you are aware there is a Royal Commission sitting at the present moment inquiring into pollutions from sewerage and similar causes, and the reference to it is a very wide one. They have already as you probably are aware, issued an interim report, and I have the advantage of the counsel and assistance in the Local Government Board of a distinguished member of that Commission, Mr. Power, who is the head of the Medical Department, and therefore, I have been able to discuss with him, before this deputation arrived, what the view is which is taken by the Royal Commission of their power with regard to general inquiry. They have issued an interim report, and one of their recommendations is this:—"We are of opinion that the general protection of our rivers is a matter of such grave concern as to demand the creation of a separate Commission, or a new Department of the Local Government Board, which should be the supreme rivers authority dealing with matters relating to rivers and their purification which, when appeal is made to them, shall have power to take action when the local authorities have failed to do so." How far they would consider that the recommendation was intended to cover, not merely rivers, but other sources of water supply, of course it is not possible for me to say; but I do not think that it is in the least probable that they would have put forward that recommendation if they looked only to sources of supply which are drawn from rivers. They are still continuing their labours, and I should be extremely reluctant to recommend the Government to appoint a Commission whose reference might seem to trespass upon the territory of the existing Commission. I should ask, in reference to this question of general pollution, that a time should be given me to learn what the opinions of this Commission are. They will, no doubt, be made acquainted with what has taken place here to-day; they will have the opportunity of reading the statements which have been made by various speakers, and I hope that they will, perhaps, think it wise and right to consider the matter and, possibly, make some communication as to the view they take of their own powers in regard to this particular question. If they hold that they are precluded by their reference from inquiry into the general question of pollution, then it might be necessary to include that in any further inquiry, if further inquiry be decided upon. I gather from what I have heard of their proceedings that they hold that their powers are ample to enable them to inquire into surface water; the question of surface water and its treatment in order to render it pure and generally to examine into the position of surface water in this country. Well, if that is so, then it would dispose at all events of a portion of the demand which has been made for inquiry here to-day, but of course it will not dispose of underground water and the general question of water rights to which I will come in a moment.

Then the second question to arise to which you draw attention is that of waste, and I am bound to say that in reference to the question of waste I have not got in my possession evidence which points conclusively in the direction indicated by the deputation to-day. The waste to which allusion has been made by one or two speakers which occurs when mining shafts are being sunk and other similar works are being carried on is generally of a very temporary character, and I am informed (and I do not put this forward in any way of contradiction to the statements which have been made)—I am informed that as a rule where there is a diminution of water supply in consequence of those operations it is only of a very temporary nature and very soon ends, things resuming their normal condition. But speaking generally, with reference to the waste question, the information which I have got is at present very meagre indeed and would not justify me in asking that an inquiry into the waste question should be included within the purview of a Royal Commission. Some additional light has been thrown upon the question to-day by the speakers in the statements which have been made, and I have no doubt that what has taken place here may lead to some further information reaching me on the subject. But in regard to the general question of water rights I admit that we stand in an altogether different position. I personally have taken considerable interest in this question long before I came to the Local Government Board, and there can be no doubt whatever that the general position of the law in regard to the protection of existing rights and their proper use for the public benefit, and the practice of local authorities in acquiring the water rights, that all this is in a very unsatisfactory condition. Not only is it the case, as we know by experience, that local authorities in their desire to supply their own district with water frequently deprive adjoining districts of water which really appears to belong to them, and while they produce satisfactory results in their neighbourhood in the shape of an adequate supply of pure water, they at the same time produce a dearth in another district which had previously been sufficiently supplied. And therefore, on the well-known principle that there is no merit in raising one man out of poverty to a position of affluence, if, at the same time, you push down two or three others into a condition of poverty—you can apply the same principle to the water question—it is very undesirable that water should be supplied to a particular area in such a way that another area to which the water properly seemed to belong and of which it would have been in enjoyment should be in consequence deprived of it. This we have had ample experience of, and it is in that way a very unsatisfactory condition of things.

Then reference has not been made here to-day except very generally to the ownership in underground water rights or the ownership in surface water rights. They are surrounded by privileges which do not attach to the ownership of other classes of property, and it would seem that this is a question which might very well be considered as a matter of inquiry and possibly also of legislation.

I cannot pretend to-day to go over the whole field covered by the various speakers because I may point out that some of the speeches which have been made would indicate a necessity for legislation not in one or two Acts of Parliament but in several Acts of Parliament, and of a very wide and general character. You know as well as I do the difficulty of promising to carry one Bill through Parliament, but when it comes to promising half a dozen, which is the lowest computation I could make of the suggestions to-day, I think a man would be rash indeed who would hold out hopes of that kind.

But the question really that you ask me to consider is not that of immediately introducing legislation, because as Mr. Halsey said in his early remarks, you come here really rather to point out defects than to indicate active or practical reforms. As I have said, I am extremely unwilling to adopt any suggestion which might have the effect of treading upon the heels of an inquiry which is now going on. I should like first of all to be fortified by some expression of opinion from the Royal Commission on Sewage Disposal which I should think in all probability I shall receive as one of the results of to-day's deputation.

Then with regard to the other questions of water rights and the general law with regard to the provision of water, because a point which has not been raised to-day but which is by no means in a satisfactory condition is the power of local authorities to secure that everybody within their area should have a proper supply of pure water. The law already lays that down, and provides machinery for the purpose, but I am afraid we must all admit that there are many districts in the country where the water supply is neither sufficient in quantity nor is it pure in quality. And therefore if that be so that reveals an unsatisfactory state of things which deserves inquiry and which certainly ought to be remedied.

I hope I have said enough to show that I am very largely in sympathy with the objects you have come here to support. I ask you to permit me not to make a definite promise on this occasion, because I should prefer to examine more completely into the whole question assisted as I am by the very luminous statements which have been made here to-day, and if I am satisfied that the case is one which ought to be presented to a Royal Commission then, to adopt the words of my friend Mr. Heywood Johnstone, who introduced the deputation—to decide to appoint a commission or a body to enquire into the question and to give them such a reference as would prevent them trespassing upon the ground of an existing Commission and which would at the same time secure that the whole question of the supply of water and the general rights of water should be inquired into with a view of such legislation being introduced as may seem to them desirable.

Mr. Heywood Johnstone.—We are very much obliged to you for your courtesy in receiving us. We note the end of your answer and we quite understand that you have grasped the importance of the subject in all its variety and its complexity, and we leave the matter in your hands; and we are quite satisfied not only with your ability but your sympathy in dealing with the subject.

The Deputation then withdrew.

COUNTY COUNCILS ASSOCIATION MEMORANDUM.

The County Councils Association desire to call the attention of His Majesty's Government to the question of the protection of sources of water supply in England and Wales and to the pressing necessity for an enquiry into the existing state of the law on the subject. In so doing they proceed on the assumption; firstly, that the question is one of great and increasing importance to the community at large; and, secondly, that the laws governing it are defective and faulty.

The Association believe that it is essential that provision should be made for a controlling authority or authorities with powers—

(*a*) To prevent water being taken, without Parliamentary sanction, for sale outside a given area to the detriment of local interests;

(*b*) To prevent waste;

(*c*) To guard against the pollution of rivers and other sources of water supply.

(*a*) It is clear that the right at common law of every proprietor to pump water on his own land may, under certain circumstances, be subject to serious abuse, if such rights are exercised for purposes for which they were never intended. For example, it has been alleged a Water Company or Local Authority may acquire rights from one proprietor under a private agreement. In certain geological formations, such as the Bunter beds, by sinking wells deeper than those in the neighbourhood and putting down powerful pumping machinery, the water contained in underground reservoirs, which drain a very large area, may be tapped, the water so procured may be conveyed to a distance to supply a population entirely outside the area from which the water is taken, and the inhabitants of the district itself may find their water-bearing strata dried up, and may be entirely deprived of their only natural water supply without any remedy or means of protecting themselves. An instance, which has been brought to the notice of the Association will illustrate this point. Certain urban districts were supplied by a local water company. Another company, wishing to increase its supply for an important centre outside the area of the local company, purchased land within the area, proposed to sink a well, and arranged with a railway company to carry the main along the railway line into its own distributing area. In the circumstances Parliamentary sanction was not necessary. The district authorities and the County Council, desirous of assisting them, were convinced that the action of the intruding company would deprive the inhabitants of the urban districts of water which was absolutely required for their own use. Still they thought they had no power to intervene for the protection of interests committed to their care.

(*b*) The evils which arise from uncontrolled waste of water in certain localities, such as the Bunter beds of Nottinghamshire and elsewhere, are perhaps more local, but, when they occur, are felt quite as acutely. It appears that until recently it was the practice of colliery companies to exclude the water contained in the permeable strata, through which the shaft passes, from the pits by lining the shaft with iron tubbing. During the sinking of a new shaft it was necessary to keep down the water by pumping, and this, in many cases, dried the neighbouring wells for a time; but, when the tubbing was placed in position, the pumping was stopped and the water in the soil returned to its former level. It seems, however, that at collieries now being opened up the plan of tubbing is abandoned, and the practice of continuous pumping to keep the water from the pit is being adopted, a separate shaft being sunk in some instances for this purpose only. Some little time ago the Association were informed of a case in which a shaft was being sunk in a new pit for pumping purposes only; and it was asserted that, long before the coal had been reached, millions of gallons of water were being pumped to waste every day. Some strong springs which had never previously been dry, at a distance of four miles from the pit had ceased to flow, and this was attributed solely to the pumping operations of the colliery proprietors.

The above are by no means the only cases in which a local water supply may be injuriously and unjustifiably affected; and yet, as the law stands, the local authorities, to whom the ratepayers are entitled to look for protection, have no power of interference.

(*c*) Closely allied to the subject of the sufficiency of water supply is its purity. It is common knowledge that, for reasons into which it is not necessary to enter here, the Rivers Pollution Act of 1876 has been nearly a dead letter. On the other hand, the rivers boards in Lancashire and in the West Riding of Yorkshire have, working through their local Acts, done much and are doing much more every year to improve the condition of the rivers and streams in their areas; and this, it is fair to point out, in a part of England where the important manufacturing interests might be expected to offer the most strenuous opposition. The Association have repeatedly introduced into Parliament a general Bill on the lines of the local measures referred to above, but have not been able to surmount the difficulties which lie in the path of a private Member of Parliament who tries to carry a Bill of this nature.

The Association would further draw attention to the defective state of the law defining the duties of local authorities in regard to water supply. The Public Health Acts of 1875 and 1878 merely impose upon the authority the obligation of "seeing that every occupied dwelling-house in their district has, within a reasonable distance, an available supply of wholesome water for the consumption and use for domestic purposes of the inmates of the house,*" but do not vest the authority with any powers to give effect to the obligation, except in a limited class of cases, in which the supply can be obtained at a cost not exceeding £13 per house. It is notorious that these duties are neglected in many of the smaller districts, and there is no power to compel the authorities to act. The result is thus expressed by the President of the Society of Engineers, in his inaugural

* *See* Sec. 3 of the Act of 1878.

address, delivered at the commencement of the present year:—"The indefinite character of existing legislation upon the relationship of private water companies to local authorities, and *vice versâ*, is also a constant source of obstruction and delay to the carrying out of sorely-needed improvements in this respect, provoking much needless opposition and litigation."

The Association would venture to believe that the consideration of facts such as these, and of others which are equally well known, lead to the conclusion that some system of control is necessary; and they would urge that the question is becoming daily more pressing when due account is taken of the increasing demand for water in consequence of a growing population, and of a greater consumption for sanitary and manufacturing purposes. The Association do not wish to express any definite opinion as to what form the control should take. This would be obviously one of the chief points for enquiry.

The Association are also strongly of opinion that a consolidation of the law governing water undertakings is called for. The law is now to be found in half a dozen or more public statutes, and in a large number of Provisional Orders and Private Acts of Parliament. Many inconsistencies exist in the provisions of these Acts; and these should be, as far as possible, removed by consolidating legislation. Another source of confusion in relation to water undertakings lies in the fact that they are at present, in varying circumstances, controlled by both Houses of Parliaments, by the Board of Trade and by the Local Government Board. The lines along which these independent bodies act are not uniform, and it would not be difficult to show that danger to public health and other evils arise from uncertainty under this head.

The Association hold that, in the present state of knowledge, the matter is not ripe for decision. They believe, and they wish to impress this upon His Majesty's Government, that there is urgent necessity for an enquiry by Royal Commission or by Parliament, to fully investigate the points which have been so briefly touched upon here, and to collect information in the hope that some effective remedy may be found for the evils which admittedly exist in connection with the question of water supply in many parts of the country.

The Association wish to add that they have been in communication with the British Association of Waterworks Engineers and the Sanitary Institute, and that the opinion of these influential bodies of professional men is in general accord with what is here expressed.

APPENDIX B.

STATEMENT prepared by Mr. A. E. Goddard showing the corresponding provisions of the Rivers Pollution Prevention Act, 1876, the Mersey and Irwell Joint Committee Act, 1892, and the West Riding of Yorkshire Rivers Act, 1894, so far as they materially differ.

<table>
<tr><th colspan="2">Rivers Pollution Prevention Act, 1876.</th><th colspan="2">Mersey and Irwell Joint Committee Act, 1892.</th><th colspan="2">West Riding of Yorkshire Rivers Act, 1894.</th></tr>
<tr><td>Part I., §2, Solid Matters.</td><td>"Every person who puts or causes to be put or to fall or knowingly permits to be put or to fall or to be carried into any stream, so as either singly or in combination with other similar acts of the same, or any other person to interfere with its due flow, or to pollute its waters, the solid refuse of any manufactory, manufacturing process or quarry, or any rubbish or cinders, or any other waste or any putrid solid matter, shall be deemed to have committed an offence against this Act.
"In proving interference with the due flow of any stream, or in proving the pollution of any stream, evidence may be given of repeated acts which together cause such interference or pollution, although each act taken by itself may not be sufficient for that purpose."</td><td>Part I., §2, Solid Matters.</td><td>Every person who—
(a) Puts or throws, or causes to be put or thrown, or to fall; or
(b) Knowingly permits to be put or to fall or to be carried; or
(c) Causes or knowingly permits to be put in such a position as to be liable to fall or to be carried into any river or stream within the jurisdiction of the Joint Committee the solid refuse of any manufactory, manufacturing process, brickyard, mine, pit-shaft, or quarry, or any ashes, cinders, or clinkers, or any building rubbish, or any sludge, or any solid sewage matter, shall be deemed to have committed an offence against this Act.</td><td>Part III., §5, Solid Matters.</td><td>Every person who—
(a) Puts or throws or causes to be put or thrown or to fall; or
(b) Knowingly permits to be put or to fall or to be carried; or
(c) Causes or knowingly permits to be put in such a position as to be liable to fall or to be carried into any river or stream within the jurisdiction of the Rivers Board the solid refuse of or sweepings from any manufactory, manufacturing process, brickyard, mine, pitshaft, quarry, workshop, or shop, or any bricks, stones, gravel, sand, earth, mud, soil, ashes, cinders, or clinkers, or any rubbish or any deposit in a reservoir, mill-dam, water-lodge, or pond, or any sludge, or any solid sewage matter, or any garbage or offal from a slaughter-house, or the carcase or portion of the carcase of any animal, or any solid matter, shall be deemed to have committed an offence against this Act."</td></tr>
<tr><td></td><td></td><td></td><td>"Provided that . . . no person shall be deemed to have committed an offence against this Act for doing, or causing to be done, any of the following acts (that is to say)—
"(1) For constructing in or across any such river or stream any building, weir, dam, or other permanent work with necessary temporary cofferdams, which but for the passing of this Act he would have a legal right to construct; or
"(2) For pitching or depositing stones or any other suitable or solid materials (not likely to be washed or carried away by the stream or current rising to the line of an ordinary flood), at the side or on the bank of any such river or stream, for the express and bonâ fide purpose of reclaiming land washed away by the action of any such river or stream, or of supporting or protecting the side or bank of any such river or stream, or of repairing the same, or of erecting or repairing any bridge or any building, drain, sewer, or watercourse upon or within the banks of any such river or stream, or the slopes or walls thereof, at or convenient to the point at which the same shall be so pitched or deposited; or</td><td>Part III., §6</td><td>Identical with the proviso to §2 of Mersey and Irwell Act with addition to paragraph (3) as shown below.</td></tr>
<tr><td></td><td></td><td></td><td>"(3) For putting into any such river or stream any sand or gravel or other natural deposit which shall have flowed from or been deposited by the current of any such river or stream.</td><td>Part III., §6</td><td>Addition as follows: "Provided that the sand or gravel or other natural deposit so put back or carried as aforesaid, do not interfere with the due flow of or pollute the waters of such river or stream."</td></tr>
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Part II., §3, Sewage Pollutions.	"Every person who causes to fall or flow, or knowingly permits to fall or flow, or to be carried into any stream, any solid or liquid sewage matter, shall (subject as in this Act mentioned) be deemed to have committed an offence against this Act.	Part II., §3, Liquid Sewage Pollution.	"Every person who causes to fall or flow or knowingly permits to fall or flow or to be carried into any river or stream within the jurisdiction of the Joint Committee any liquid sewage matter shall (subject as in this Act mentioned) be deemed to have committed an offence against this Act."	Part IV., §7 (1), Liquid Sewage Pollution.	Same as §3 (first paragraph) of Mersey and Irwell Act.
	"Where any sewage matter falls or flows, or is carried into any stream along a channel used, constructed, or in process of construction, at the date of the passing of this Act for the purpose of conveying such sewage matter, the person causing or knowingly permitting the sewage matter so to fall or flow or to be carried, shall not be deemed to have committed an offence against this Act if he shows to the satisfaction of the Court having cognisance of the case that he is using the best practicable and available means to render harmless the sewage matter so falling or flowing or carried into the stream.	(First paragraph).			
	"Where the Local Government Board are satisfied after local inquiry that further time ought to be granted to any sanitary authority, which at the date of the passing of this Act is discharging sewage matter into any stream, or permitting it to be so discharged, by any such channel as aforesaid, for the purpose of enabling such authority to adopt the best practicable and available means for rendering harmless such sewage matter, the Local Government Board may by order declare that this section shall not, as far as regards the discharge of sewage matter by such channel, be in operation until the expiration of a period to be limited in the order. "Any order made under this section may be from time to time renewed by the Local Government Board, subject to such conditions, if any, as they may see fit.	Part II., §4.	Section in Mersey and Irwell Act granting time for execution of works in the case of existing pollutions reads as follows :— "On the application of any sanitary authority who at the passing of this Act is committing any offence within the meaning of the last preceding section [§3], the Joint Committee may, if having regard to all the circumstances of the case they think necessary, by order grant time to such authority for executing any works or doing any acts necessary to prevent the commission of the offence, and during the time specified in the order (which may be extended by a subsequent order), no proceedings under the said section shall be taken by the Joint Committee against the authority named in the order."	Part IV., §8	Corresponding section in West Riding of Yorkshire Rivers Act reads as follows :— *On the application of any sanitary authority which at the passing of this Act is committing any offence within the meaning of the last preceding section, the Rivers Board may, if having regard to all the circumstances of the case they think necessary by order grant time to such authority for* or with respect to the executing of any works or the doing of any acts necessary to prevent the commission of the offence. "The Rivers Board may in such order prescribe the several periods within which any successive steps preliminary to and requisite for the obtaining of power to execute such works or to do such acts shall be taken by such sanitary authority, and the period for the execution of the said works and for doing the said acts, and such periods or any of them may be extended by a subsequent order. "Unless and until such sanitary authority make default in taking any such steps, or executing any such works, or doing any such acts within the time prescribed in that behalf in such order, no proceedings under the said section shall be taken by the Rivers Board against the authority named in the order.
	"A person other than a sanitary authority shall not be guilty of an offence under this section in respect of the passing of sewage matter into a stream along a drain communicating with any sewer belonging to or under the control of any sanitary authority, provided he has the sanction of the sanitary authority for so doing."	Part II., §3 (last paragraph).	Same as in §3 of Rivers Pollution Prevention Act, 1876 (last paragraph).	Part IV., §7 (last paragraph).	Same as in last paragraph of section 3 of Mersey and Irwell Act, with an addition as follows :— "Where any liquid sewage matter falls or flows or is carried into any stream after passing through or along a channel which is vested in a sanitary authority, the sanitary authority shall be deemed to knowingly permit the liquid sewage matter so to fall, flow, or be carried." (This is identical with §1 of Rivers Pollution Prevention Act, 1893.)

APPENDIX B—*continued.*

STATEMENT prepared by Mr. A. E. Goddard showing the corresponding Provisions of the Rivers Pollution Prevention Act, 1876, the Mersey and Irwell Joint Committee Act, 1892, and the West Riding of Yorkshire Rivers Act, 1894, so far as they materially differ—*continued.*

Rivers Pollution Prevention Act, 1876.		Mersey and Irwell Joint Committee Act, 1892.		West Riding of Yorkshire Rivers Act, 1894.	
Part III., §5.	" Every person who causes to fall or flow, or knowingly permits to fall or flow, or to be carried into any stream any solid matter from any mine in such quantities as to prejudicially interfere with its due flow, or any poisonous, noxious, or polluting solid or liquid matter proceeding from any mine, other than water in the same condition as that in which it has been drained or raised from such mine, shall be deemed to have committed an offence against this Act, unless in the case of poisonous, noxious, or polluting matter he shows to the satisfaction of the Court having cognisance of the case that he is using the best practicable and reasonably available means to render harmless the poisonous, noxious or polluting matter so falling or flowing, or carried into the stream."	Part IV., §15	" Notwithstanding anything in this Act contained no person shall be deemed to have committed an offence against this Act, or be liable to any proceeding under this Act, by reason of or in consequence of any water flowing into the river . . . in the same condition as that in which such water has been drained or raised from any mine pit, shaft, or quarry, or by reason or in consequence of any water flowing into the river . . . from any colliery or pit bank or by reason or in consequence of any water so flowing which has passed through an efficient settling tank in connection with any coal washing machinery."	Part VII., §22.	(Same as section 15 of Mersey and Irwell Act.)
Part III., §6.	" Unless and until Parliament otherwise provides, the following enactments shall take effect:— " Proceedings shall not be taken against any person under this part of this Act, save by a sanitary authority, nor shall any such proceedings be taken without the consent of the Local Government Board. " Provided always, that if the sanitary authority, on the application of any person interested alleging an offence to have been committed, shall refuse to take proceedings or apply for the consent by this section provided, the person so interested may apply to the Local Government Board, and if that Board on inquiry is of opinion that the sanitary authority should take proceedings, they may direct the sanitary authority accordingly, who shall thereupon commence proceedings. " The said Board, in giving or withholding their consent, shall have regard to the industrial interests involved in the case, and to the circumstances and requirements of the locality. " The said Board shall not give their consent to proceedings by the sanitary authority of any district which is the seat of any manufacturing industry, unless they are satisfied, after due inquiry, that means for rendering harmless the poisonous, noxious, or polluting liquids proceeding from the processes of such manufacturers are reasonably practicable and available under all the circumstances of the case, and that no material injury will be inflicted by such proceedings on the interests of such industry.	Part III., §6	" (1) Proceedings shall not be taken under this part of this Act against any person without the consent of the Local Government Board. " (2) The Joint Committee shall, one month at least before taking proceedings . . . . against any person, serve, by post or otherwise, on such a person a written notice inviting him, if he desires to show cause why proceedings should not be taken, to appear before the Joint Committee at a time and place to be specified in the notice. " (3) If the Joint Committee, after either hearing such person, or in default of his appearance, decide that proceedings ought to be taken, they shall forthwith notify their decision, and the grounds thereof, to such person, and to the Local Government Board, and shall apply for the Board's consent. " (4) The Board may hold a local Inquiry into the circumstances of the case, but shall inform the Joint Committee and each person whether they give or withhold their consent before the expiration of three months from the date of the Joint Committee's application for it. " (5) The Joint Committee shall not take proceedings against any person under this part of this Act, and the Local Government Board shall not give their consent to such proceedings unless the Joint Committee and the Board respectively are satisfied that means for rendering harmless the poisonous, noxious, or polluting liquids are reasonably practicable and available under all the circumstances of the case.	Part V., §11	(1) Same as paragraph (1) of section 6 of Mersey and Irwell Act. (2) The Rivers Board shall, one month at least before taking proceedings under this part of this Act against any person, serve by post or otherwise on such person a written notice requring him to show cause before the Rivers Board (at a time and place to be specified in the notice) why proceedings should not be taken against him under this part of this Act. (3) Same as paragraph (3) of section 6 of Mersey and Irwell Act. (4) Same as paragraph (4) of section 6 of Mersey and Irwell Act, omitting the words after " consent." (5) Same as paragraph (5) of section 6 of the Mersey and Irwell Act, with the following additions:— (*a*) After " satisfied "—" after due inquiry, and having regard to the reasonableness of the cost and the effect on the industry or trade in question." (*b*) At end: " and that no material injury will be inflicted by such proceedings on the interests of such industry or trade."

	"Any person within such district as aforesaid against whom proceedings are proposed to be taken under this part of this Act shall, notwithstanding any consent of the Local Government Board, be at liberty to object before the sanitary authority to such proceedings being taken, and such authority shall, if required in writing by such person, afford him an opportunity of being heard against such proceedings being taken, so far as the same relate to his works or manufacturing processes. "The sanitary authority shall thereupon allow such person to be heard by himself, agents, and witnesses, and after inquiry such authority shall determine, having regard to all the considerations to which the Local Government Board are, by this section, directed to have regard, whether such proceedings as aforesaid shall or shall not be taken. "And where any such sanitary authority has taken proceedings under this Act it shall not be competent to other sanitary authorities to take proceedings under this Act till the party against whom such proceedings are intended shall have failed in reasonable time to carry out the order of any competent Court under this Act."				
Part IV., §7, Sanitary Authority to afford facilities for factories draining into sewers.	"Every sanitary or other local authority having sewers under their control shall give facilities for enabling manufacturers within their district to carry the liquids proceeding from their factories or manufacturing processes into such sewers : "Provided that this section shall not extend to compel any sanitary or other local authority to admit into their sewers any liquid which would prejudicially affect such sewers or the disposal by sale, application to land, or otherwise, of the sewage matter conveyed along such sewers, or which would, from its temperature or otherwise, be injurious in a sanitary point of view : "Provided also, that no sanitary authority shall be required to give such facilities as aforesaid, where the sewers of such authority are only sufficient for the requirements of their district, nor where such facilities would interfere with any order of any court of competent jurisdiction respecting the sewage of such authority."		(No corresponding clause in Mersey and Irwell Act.)	Part V. §10	Same as section 7 of Rivers Pollution Prevention Act.
Part IV. §10, Procedure, §11.	Offences to be restrained by summary order of County Court. Appeal from County Court, and removal of case into High Court of Justice.	Part IV., §8, Procedure, §9.	Offences to be prosecuted and penalties recovered in a summary manner before a court of summary jurisdiction. Appeal to Court of Quarter Sessions.	Part VI., §13, Procedure, §14.	Same as section 8 of Mersey and Irwell Act. Same as section 9 of Mersey and Irwell Act, but with a further right of appeal to the High Court (§14 (2)).

APPENDIX B—*continued.*

STATEMENT prepared by Mr. A. E. Goddard showing the corresponding provisions of the Rivers Pollution Prevention Act, 1876, the Mersey and Irwell Joint Committee Act, 1892, and the West Riding of Yorkshire Rivers Act, 1894, so far as they materially differ—*continued.*

Rivers Pollution Prevention Act, 1876.	Mersey and Irwell Joint Committee Act, 1892.		West Riding of Yorkshire Rivers Act, 1894.	
(No power of entry in Rivers Pollution Prevention Act.)	§10, Power of Entry.	" For the better enforcement of the provisions of this Act, it shall be lawful for any officer of, or other person authorised by the Joint Committee, at any time to enter on any lands, manufactory, or other work or building, for the purpose of taking and carrying away, and to take and carry away, samples of any effluent at the point where it passes into any river or stream within the jurisdiction of the Joint Committee. Such officer or person shall leave under seal a duplicate of every sample taken by him with the owner or occupier of the premises whence the effluent flows. " Any person who obstructs or molests any such officer or other person shall be liable to a penalty not exceeding five pounds."	§15, Power of Entry.	" (1) For the better enforcement of the provisions of this Act, it shall be lawful for any officer of, or other person authorised by the Rivers Board and producing his written authority if required so to do, at any time to enter on any land, manufactory, or other work or building for the purpose of taking and carrying away, and to take and carry away, samples of any effluent at the point where it passes into any river or stream within the jurisdiction of the Rivers Board. " (2) Any person who obstructs or molests any such officer or other person shall be liable to a penalty not exceeding five pounds. " (3) Such samples shall be taken by such officer or person in triplicate, and shall thereupon before they are taken from the premises be respectively sealed up and marked by him, and he shall leave one of such triplicate samples with the occupier of the premises whence the effluent flows, another shall be submitted by the Rivers Board (if they think fit) for analysis, and the third shall be retained by the Rivers Board for future comparison."

ROYAL COMMISSION ON SEWAGE DISPOSAL.

THIRD REPORT

OF

THE COMMISSIONERS

APPOINTED IN 1898

TO INQUIRE AND REPORT WHAT METHODS OF

TREATING AND DISPOSING OF SEWAGE

(INCLUDING ANY LIQUID FROM ANY FACTORY OR MANUFACTURING PROCESS)

MAY PROPERLY BE ADOPTED.

1. TRADE EFFLUENTS.
2. A NEW CENTRAL AUTHORITY.

VOL. II. EVIDENCE.

Presented to both Houses of Parliament by Command of His Majesty.

LONDON:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE,
BY WYMAN AND SONS, LIMITED, FETTER LANE, E.C.

And to be purchased, either directly or through any Bookseller, from
EYRE AND SPOTTISWOODE, EAST HARDING STREET, FLEET STREET, E.C.; and
32, ABINGDON STREET, WESTMINSTER, S.W.; or
OLIVER AND BOYD, EDINBURGH; or
E. PONSONBY, 116, GRAFTON STREET, DUBLIN.

1903.

[Cd. 1487.]


THE ROYAL SANITARY INSTITUTE, FOUNDED 1876.
SALUS GENERIS HUMANI.

MINUTES OF EVIDENCE

TAKEN BEFORE THE

ROYAL COMMISSION

APPOINTED TO

Inquire and Report: First, what method or methods of treating and disposing of Sewage (including any Liquid from any Factory, or Manufacturing Process) may properly be adopted consistently with due regard for the requirements of the existing Law, for the protection of Public Health, and for the economical and efficient discharge of the duties of Local Authorities; and if more than one method may be so adopted, by what rules, in relation to the nature or volume of Sewage, or the Population to be served, or other varying circumstances or requirements, should the particular Method of Treatment and Disposal to be adopted, be determined; and, secondly, to make any Recommendations which may be deemed desirable with reference to the Treatment and Disposal of Sewage.

THIRTY-SIXTH DAY.

Tuesday, 6th May, 1902.

PRESENT:

Sir MICHAEL FOSTER, K.C.B., M.P., F.R.S. (*Chairman*).

Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Mr. W. H. POWER, F.R.S.
Professor WILLIAM RAMSAY, F.R.S.
Colonel HARDING.
Dr. JAMES BURN RUSSELL.

Mr. F. J. WILLIS, *Secretary*.

Mr. ALGERNON F. FIRTH, called in; and Examined.

Mr. A. F. Firth.

6 May 1902.

10257. (*Chairman.*) You are managing director of Messrs. T. F. Firth and Sons, Limited, of Clifton Mills, Brighouse, and Flush Mills, Heckmondwike?—Yes.

10258. You are vice-president of the Firth Carpet Company, Firthcliffe, New York?—Yes.

10259. May I ask you, at your two establishments at Clifton Mills and at Flush Mills, in the first instance you discharge a considerable quantity of trade effluent into what?—Into two streams, one at each place.

10260. Beginning with the Clifton Mills at Brighouse, you discharge your trade effluent into——?—Into the stream, after treating the soap-suds.

10261. What is the stream called?—Well, it is called the Cliftonbeck; it runs down into the Calder through Brighouse.

10262. And what is the amount of your discharge per week, for instance?—We estimate—of course it varies considerably—18,000 gallons from soap-suds and from the dyehouse about 30,000 gallons, and from print works, which is our largest business, about 180,000 to 200,000 gallons. May I explain about that effluent, the largest amount, that the nature of our business is printing, and the greater the amount of effluent the better the goods are, so it is mostly washing-off water.

10263. (*Mr. Power.*) Are they separately discharged, the effluents, or are they combined?—The soap-suds are run into tanks, cracked, and the effluent discharged into the stream; those tanks away from the mill.

10264. It goes separately to the stream?—Yes, but our mills are built over the stream, and the other effluents go into it.

10265. (*Chairman.*) Can you state very briefly and generally the nature of your effluent?—The effluent from the soap-suds, of course you know that after it has been cracked——

10266. May I ask what is exactly meant by "cracking"—it is a technical phrase?—Well, the soap-suds from the scouring process are run into tanks, and acid—I think sulphuric acid—put in, and that cracks them, and the grease is deposited, and the effluent run off; eventually there may be a little grease left in, but precious little, nothing like as bad as domestic sewage, domestic soap-suds.

10267. That is one kind of effluent?—Yes, that is one effluent to which these figures, 18,000 gallons, refer.

10268. Then there is the effluent from the dye house?—That is nearly all simply discoloured water. There is hardly any solid in it; it has a shade of acid, of course; it is discoloured water.

10269. Does the acidity vary very much?—No.

10270. May it sometimes be very acid?—No, very slightly acid. The percentage of acid is simply to fix aniline colours, ours is really all aniline dyeing.

10271. Could you say roughly what the amount of free acid is?—I could not; I could ascertain if you wish to know.

10272. Then, from the print works?—From the print works this is just exactly the same process. We have the same constituents, we use no woods of any sort, nothing but aniline colours hardly.

10273. And that, again, would be mostly dye water, in fact?—It is virtually dye water, and we turn on as much water as ever we can through, because the more we turn on the brighter the colours come, therefore that is a very thin effluent indeed.

10274. And at present you discharge the whole effluent into the stream?—Yes.

10275. But you are constructing tanks?—Yes, we are arranging tanks at the request of the Rivers Board, complying with their requirements to get the solids out of the effluent before turning it into the stream. These are being constructed now at Clifton Mills, Brighouse.

10276. (*Professor Ramsay.*) The water is still very much discoloured?—Discoloured, certainly.

10277. Are you thinking of adding anything, such as alumino-ferric, to take out the colour?—We have not thought of doing so; we understand under the Act at the present time this discoloration is no pollution.

10278. I thought there was something in the 1868 Act?—Yes, we are advised that discoloration is no pollution.

10279. (*Mr. Power.*) Are the tanks to receive the total effluent—the combined effluent—from the three sources?—No, the 18,000 gallons from the soapsuds go separately. Those have tanks now; they are further down the stream; they would have nothing to do with this other.

10280. (*Chairman.*) At the Flush Mills it is very much the same, I suppose?—No, there is very little printing there, chiefly the dye-house, a certain amount of milling. That is a woollen mill, the other is a carpet mill.

10281. Does that bring about any great change in the nature of the effluent—the milling?—No, absolutely

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6 May 1902.

none; but there, again, we crack our soapsuds. We have tanks for the purpose, but with the other we have not done anything; we have not built tanks; we are waiting to know what the local authority is going to do. The local authority is at the present time receiving the effluent of certain manufacturers, but will not undertake to do so generally; therefore we consider if they take some they should take all.

10282. (*Major-General Carey.*) If they could?—Certainly, they could make regulations to take all if they take any.

10283. Supposing their outfall sewer was not large enough to take them?—If they do not take all, why should they take any? We are by far the largest ratepayers in the township, that is at Heckmondwike.

10284. (*Chairman.*) Do you either at Brighouse or Heckmondwike obtain your water from the stream or from another source, wholly or partially?—At Brighouse we obtain the greatest portion from the stream, but we are first on the stream there. Then we use a considerable amount of town's water for the dye-house, and also for the boiler; sometimes at Heckmondwike we use the town's water and pump, and also have a very small stream; we are built on the stream.

10285. At Brighouse more especially do you consider the riparian owners below you can compel you to return the water which you have taken into the stream?—Certainly.

10286. And that applies, then, considerably at Brighouse and to a small extent at Heckmondwike?—Yes.

10287. You take the town's supply there to a large extent?—To a large extent; but as far as the riparian rights are concerned there, the main stream runs down the valley, and ours is a very small stream running into the main stream, and I think nothing we could do to that main stream would affect riparian rights at all.

10288. (*Mr. Power.*) As a matter of fact, you take a very small proportion of the water supply at your Heckmondwike works from the stream?—I cannot give you the exact figures; I should not say a very small proportion, but a small proportion.

10289. You say you are using much more water at Heckmondwike than you are at Brighouse?—That, again, is for washing off largely; nine-tenths would be for washing off, getting bright colours.

10290. (*Chairman.*) Are you of the opinon that the rights of manufacturers and local authorities—their relative rights—are clearly defined by the existing law?—No; I do not consider they are.

10291. I suppose the two points of importance are on the one hand, whether, when you discharge into a sewer, the sewer is big enough to take your effluents?—Certainly.

10292. And in the second place, whether there are any substances or constituents of your effluent which would interfere with the due purification of the sewage?—Certainly.

10293. Which do you think is the more important one, the one which raises the greater difficulties, the size of the sewer or the nature of the effluent?—Which raises the greater difficulty?

10294. Yes?—From the local authorities' point of view?

10295. Yes, between the manufacturer and the local authority?—The size of the sewer.

10296. The size of the sewer?—Certainly.

10297. That is the most common difficulty between the manufacturer and the local authority?—Certainly, from the fact that there are no sewers at all such as could serve our mill at Brighouse. There are no sewers; it all goes into the stream; the whole of the sewage of the Hipperholme district runs into the stream.

10298. The question of the nature of the effluent interfering with the treatment of the sewage is quite subordinate?—Certainly.

10299. That question does not arise very often in your experience?—In my experience not at all. There is nothing in our effluent of any sort whatever that would interfere with the treatment of the town sewage.

10300. (*Professor Ramsay.*) Not even grease in your case?—Well, we take the grease out, you see, the biggest part of it, and the effluent that would go from our soapsud tanks contains far less grease than any domestic water from washing or anything of that sort.

10301. There are two ways in which it might contain grease. First of all, in the form of soap, and secondly, in the form of grease, fatty acids got from soap, I understand. The real grease you get by treating the soap. I do not know, but I am prepared to suggest that the house refuse, which consists mainly of soap, is not nearly so difficult to treat as your effluent, which contains grease separate from soap, although perhaps in much smaller quantity?—Yes, of course. I am not an expert on that, but I should say, as far as I know, there is very much less grease in ours and very little acid. Of course, if they crack it carelessly they put too much acid in, but it is against their own interest to do so. They put as little acid in as possble, the people who contract for this.

10302. (*Chairman.*) You are, then, as a manufacturer, dissatisfied with the law at present?—Yes, I am.

10303. And you think it should be so modified as to give the manufacturers greater rights to connect up to sewers?—Yes, I do. I consider the system at the present time of giving some the power and not others, and also the limitation that exists at the present time whereby some have to treat and connect with the sewers and others cannot is unfair. For instance, in towns a man has not got to treat it if he can prove that he has not room to treat it; and yet we in the country, if we have a little bit of ground alongside, are forced to go to the expense of hundreds, or even of thousands of pounds to treat our sewage.

10304. (*Major-General Carey.*) If the manufacturer has not got room to treat his trade effluent, and that effluent is discharged into the sewers, the local authority would have to treat it?—The local authority, I suppose, would have to if it is discharged into the sewers; but in the majority of cases that I know of they discharge into the stream at the present time.

10305. I am assuming that the local authority do take it?—Yes.

10306. If they take an untreated effluent they have to treat it?—Certainly.

10307. And in that case they would require a contribution, would they not, from the manufacturer?—From the individual manufacturer.

10308. From the individual?—No; his rates ought to cover that.

10309. But as an individual he is largely responsible for the difficulty in treatment of the combined sewage and trade water, and why should his rates cover much more than the rates of any other ratepayer?—I consider that if it is to the advantage of the public that it should be treated they should pay the cost. I know instances where the individual manufacturer pays more than half the rates of the township, and he has to pay for all the treatment of the domestic sewage, and that of the other industries that come into the sewers, and why should his not be treated in exactly the same way by the local authority?

10310. (*Chairman.*) Do you think that any further safeguards than those at present provided are required to secure that the refuse shall be delivered in such a condition and in such regular quantities as not to interfere with the purification of the sewage?—I think the only reasonable safeguard is that the manufacturer should remove his solids. I do not think there is any objection to ordering a manufacturer to remove his solids from his trade refuse. I very rarely met with a case where a man, talking of it, objects to take his solids out; what he objects to is not knowing what he has got to do.

10311. Do you think that would be in all cases adequate; is it not possible, for instance, that there might be dissolved in the effluent after the extraction of the solids, some substances which, mixing with the domestic sewage, should lead to a precipitation which would interfere with the purification of the sewage, or that, on the other hand, there might be still in solution substances, say, of a poisonous nature, which again might interfere with the purification of the sewage?—I think such a thing is possible, of course; but I think it is very special indeed.

10312. And therefore it would be met by special precaution?—Yes; but I think in the majority of instances, such a case would never arise. Any special precautions might be stretched in such a way as to give very great trouble to manufacturers, where it is really of no importance whatever to the public health or any danger to anybody else.

10313. Your view is based upon the supposition that

in at all events the vast majority of cases, the mere removal of the solids would permit the trade effluent mixing with sewage to undergo the necessary purification?—Certainly, I think so. I think if there were special cases where it was deleterious, that those might be met by the Rivers Board, with appeal to the courts if necessary.

10314. Then as to the pouring of your effluent into the sewer in regular quantities. Obviously, if the quantities vary very considerably, such variations may very materially interfere with the due actions of the precautions taken to purify the sewage?—Yes.

10315. Can you make any suggestions as to regulations with regard to ensuring regular quantities of the effluent being discharged, or known quantities of the effluent being discharged into the sewer?—I think it would be almost impossible to make safeguards; because, for instance, you know, Colonel Harding, we let off dye-vats, for instance, at breakfast-time and dinner-time, fill them up again just before the mill stops for dinner; there is a lot of dye-vats being let off into the stream or into the tanks; but as for discharging it into the sewers in regular quantities, I think it would be absolutely impossible to make any engagement.

10316. (*Mr. Power.*) You could make your tank feed the sewers regularly?—You could if you have the land or the money; but some manufacturers have not either to spare for that.

10317. (*Major-General Carey.*) How is the local authority to take manufacturers' effluent when it comes down in uncertain volumes, perhaps 100,000 gallons in one hour, and 10,000 or 20,000 gallons in the next?—They could make provision for it in one way or another. They would know probably that different trade effluents are being discharged into the sewers at different times, and the average would come about right. I do not see how they could force a manufacturer to turn his effluent down in regular quantities.

10318. (*Colonel Harding.*) As a fact, they do in different places force the manufacturer to turn his effluent out at a regular speed of flow, and it is found to be practicable?—I am not posted on that. You are far better able to speak about that than I am; but I should imagine it would be very difficult at our works to say to the men: "Well, you are to turn this stuff down in regular quantities."

10319. (*Chairman.*) And the expense of anything like a supply-tank would be greater than you ought to be asked to bear?—I think so; it would work very great injustice to small manufacturers—men who are not in a position to do it.

10320. Have you any other suggestions to make as to further safeguards which are required, what they should be, and how they should be carried out?—Safeguards as to the condition of the sewage, I understand, of the refuse.

10321. Safeguarding the purification of the sewage against the features of the effluent?—No, I think that the only safeguard should be to establish a reasonable standard of the effluent, as far as solids are concerned, or as far as acidity is concerned, and make this reasonable, and I think manufacturers would willingly comply with it.

10322. Do you see any difficulty in an examination chamber, I mean at the entrance of your effluent into the sewer, so that the authorities could examine whenever they pleased, both the nature and the rate of flow of the effluent?—An examination chamber?

10323. Yes, a manhole?—Well, yes; the local authority would have a perfect right to put manholes where they like, and do as they please in examining a man's sewage, if they were taking it.

10324. And you see no objection?—None, whatever.

10325. (*Professor Ramsay.*) Would it be possible for several manufacturers to combine, and treat their sewage together in your district?—In my district it would not at all, because the mills below us on the stream are all cotton spinners and wire mills, and there is one at one and one at another place. They are into the main stream immediately; we could not combine with anybody that I see.

10326. (*Chairman.*) Supposing there is a series, I do not know whether it ever occurs anywhere—a series of manufacturers on a stream, one immediately below the other—a chain of them?—Yes.

10327. Would it be possible for a combination to take place, so that I mean the whole stream at the end of the last manufactory could be purified at the expense of all of them?—Certainly.

10328. That *pro rata*, according to the amount of the discharge of the sewage?—That would be possible, but the friction about it would be enormous, and it is so very rare that you find on a stream many mills in the same business.

10329. Then you think manufacturers are prepared to adopt reasonable means for the removal of suspended solids and so on in their trade refuse, before it is thrown into the sewer?—As far as my experience goes they are quite prepared, particularly in the country districts; I do not think they would object to anything that is reasonable. Of course, as far as the towns are concerned, I have considerable experience of Halifax. I have been president of the Chamber of Commerce there until last year, and I know that there they are in a very different position, that they have got only a very small stream running through the town; most of the manufacturers use town water, and they turn the soapsuds at the present time into the sewers, and, I suppose, the corporation treat it. I really am not posted on that, but I believe they do; and it would be unjust to make some there purify their own sewage, just because they have got a piece of land alongside—it is very valuable land—and say: "You must take it for this purpose," and let others, simply because they have not got land, turn the effluent into the sewers.

10330. Do you think there would be an advantage in the existence of some tribunal, to which an appeal could be made when a local authority refuses to allow trade refuse to go into the sewers?—I do not think there is any special tribunal necessary, I think the present ones are quite sufficient.

10331. I do not know whether you looked at the interim report that we issued, in which we made a suggestion that there should be a supreme rivers authority, as we proposed to call it, which should be the court of appeal in various questions arising out of the disposal of sewage. Would it be of advantage to appeal to a central body of that kind, which would probably have a great deal of expert knowledge at its disposal, rather than the not always satisfactory method of going to a court of law?—I did not read that report. Do I understand that that was a judicial court.

10332. It might be used at all events as a court of appeal, to decide questions of difference between conflicting interests?—I should infinitely prefer to leave the appeal or the jurisdiction to the present courts, because on these bodies, in my opinion, you would probably get a number of cranks or men who knew nothing at all about business.

10333. You are speaking now of the supreme river authority?—Yes. Even on Rivers Boards you do, Colonel Harding.

10334. (*Colonel Harding.*) On the other hand, if there is the danger of getting the cranks you tell us about on the central authority, is there not a danger that in the magistrates' courts, which are now called upon to decide these matters, the Bench may be actually formed of manufacturers who are deeply interested in these very questions, and who may, therefore, give a somewhat prejudiced verdict?—My experience of magistrates, and I am sure yours also, is that the magistrates act upon the law in nearly every case; they do not use their own personal interest to evade the law in any way; they are sworn to maintain the law, and they are bound to do so, and I do not think their personal feeling is anything like so dangerous as that of a number of persons who might be on an authority of that sort.

10335. (*Chairman.*) The Supreme Rivers Authority we were advocating was a department of the Government?—Of course I do not use the word "cranks" in any offensive sense; I mean men who will have the object arrived at of purifying the stream, never mind at all what the result is to the trade interest of the country or the injustice worked to the individual manufacturer.

10336. Well, but the Supreme Authority which we had in view was one which was acting in the interests of the nation?—Well, I prefaced my remark by saying that I was not posted on the authority you recommended.

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10337. But you have complete confidence in the ordinary Court of Law?—Certainly.

10338. (*Colonel Harding.*) Because they are made up very often of manufacturers who would have a special sympathy?—No, that is not my reason at all; they are not to a great extent. In some courts you hardly see a manufacturer on; and even on my own bench there is a number who are not manufacturers.

10339. Did you hear a notorious instance recently in which a Rivers Board case was tried by a bench of magistrates, everyone of whom had either been prosecuted by the Rivers Board, or was connected with a firm that had been so prosecuted?—Where was that?

10340. I think it was at Saddleworth?—I know, yes, I attended one quarter-sessions, at which we had one case from that district, and we decided by a narrow majority against the Rivers Board, and our decision was upheld by the court here. That was on the question of "slushing a dam." It was taken to the higher courts by the Rivers Board, and they were squashed, which proved that our decision was right.

10341. (*Chairman.*) What is your view as to the proposal that manufacturers should pay a special rate or charge in those cases where they are allowed to connect with the sewers?—I consider it would be very unfair. Manufacturers are taxed quite enough as it is at present. They pay the bulk of the taxation of the country, and of the local taxation, too; and I consider if it is the interest of the locality that such things should be done, well, let the locality pay. But why they should be at the whole expense of this, besides in most cases paying the bulk of the rates of a district, I cannot understand. It is very different from my experience in America. There, if you think of establishing an industry in a town or in a locality, they are really to come to you and beg you to go there, and let you off all rates and taxes for three or four years —except the Government State taxes—to get you into the place. Everything is done to encourage industry, and not all sorts of things put forward—that manufacturers should pay special rates, and extra charges, and so on. The tendency lately has been to make it far more difficult for a man to conduct his business than it ever was before; and it seems to be the tendency of modern legislation to pile charges and restrictions upon him, which I think very injudicious, and injurious to the commercial development of the country.

10342. In that respect you observe a marked contrast between your position in England and your position in America?—Oh, very great. There we can send down the streams what we like, so long as we do not interfere with the men below.

10343. Surely there would be a difference between the Clifton Beck and the Mississippi, would there not? —A difference in size, of course. But it is not everybody who is on the Mississippi, or even on the Hudson.

10344. But what I mean is, it depends on the importance of the stream. On a stream of vast volume, if a single manufacturer comes there he cannot do serious injury. Some streams in your own district, which are crowded with manufactories, are very much more liable to serious results from pollution?—Yes; but I am referring to the small streams in America, the number of small streams. The most of the mills are on the small streams, where they can get water power, which they cannot get out of a big river like the Mississippi or the Hudson without big expense.

10345. May I ask where your establishment in Firthcliffe is?—In the State of New York, on a stream near the Hudson.

10346. Discharging into the Hudson?—Discharging into the Hudson.

10347. (*Major-General Carey.*) Suppose a number of manufacturers were going to the expense of treating the trade-effluent on their own property. Would they not complain if the authority were to take a trade-effluent—a non-treated trade-effluent—from other manufacturers into their sewers without any contribution. They have already gone to the cost of treating their own effluent, and so must be all on the same lines?—Of course, that is quite true. Then I say the manufacturers, as I understand at the present time, are not forced to do more than take the solids out, and I should make them all take the solids out if I could; of course, except in towns, where a man has not the land; but my position is, that the manufacturer should take his solids out.

10348. In all cases?—Yes, up to a reasonable standard. I think he should, if he possibly can. If there is any reason why he should not in a town, that it i absolutely impossible, well, then, it may be different When I say I object to a special rate, of course, am referring to my own experience—my own localities but in a town I can quite see it may be possible, wher they take certain manufacturers into the sewers, tha they should levy a rate upon those manufacturers.

10349. (*Chairman.*) When you say remove th solids, I suppose you would add to that, in cases wher it was necessary, precautions against too great acidity —Certainly.

10350. Or too great alkalinity?—Yes.

10351. And in a few special cases in which there ar special substances, though in solution, those should b treated also?—Yes; I think that is perfectly fair.

10352. Could you state generally to the Commissior what are the main difficulties which the manufacture meets with usually in dealing with local authorities and what are the reasons generally advanced by loca authorities for refusing to allow trade refuse to go int their sewers?—Certainly; either that the local autho rity in some cases has no system of sewage at all, o virtually none.

10353. Is that the case at either of those place where you have works in the West Riding, Heckmond wike, or Brighouse?—At Hipperholme. Of course, ou works are outside Brighouse, in the Hipperholme Urban District Council district, and there they hav a system of sewage, but it is unworked; they are ex perimenting with the serena system, but they hav not arrived at anything efficient, and virtually th whole of the sewage in our locality is turned into thi very same stream.

10354. (*Major-General Carey.*) That is a temporar matter?—Well, it has been a very long time temporary

10355. They are trying to combine with th other authorities?—They have been talking abou it for years, but meantime this system is goin on, and I, for one, have protested very strongly agains it, because I consider it is one of the most disgraceful cases of danger to public health that there is in th West Riding. I daresay you know all about it, Colone Harding. It is virtually turned in at the same spo as our effluent, and there is the sewage, I suppose of 2,000 or 3,000 people going in at that point, and a lot more down below, several thousands more, without any treatment at all.

10356. (*Chairman.*) Untreated?—Yes.

10357. The sewage turned into the system untreated? —Yes; and then the Rivers Board come and make us put in tanks, and they let the local authority turn in this amount of sewage without a word; they go on all the time.

10358. (*Colonel Harding.*) Oh, I think surely you are quite wrong there?—I know you have talked to them, but it has had no effect, and theirs is a thousand times worse than ours; in fact, there have been objections to the local authorities, and remonstrances by those who live on the borders of this stream, against this awful stench in summer. The local authority is dealing with the matter, but they are very slow about it. I am a large ratepayer, and it is to my interest pecuniarily that they should put it off as they are doing; but I do not care to speak about that if they only purify the water and stop this fearful nuisance.

10359. (*Chairman.*) Then the difficulties are that there are either no sewers, or the sewers are not large enough?—Or the sewers are not large enough.

10360. And that there are no adequate standards? —Certainly.

10361. Could you state your opinion as to what would be the effect upon the flow of the water in a stream if the trade refuse were diverted from it into a public sewer?—Oh, very serious.

10362. (*Colonel Harding.*) Well, there would not, in fact, be any stream?—There would; in our case we do not use half the stream.

10363. But in many cases there would be no stream at all?—In many cases there would be no stream at all. Take the stream through Halifax—there would be none whatever.

10364. (*Chairman.*) Does it apply to a good stream of tolerably pure water, as well as of dirty water; that applies to a stream where the water is already impure? —There is hardly a stream in Lancashire or Yorkshire

that would be of any size at all if the manufacturers turned all the water they used into the sewers.

10365. (*Mr. Power.*) Is the stream polluted at Hipperholme before it comes to you at your works there?—Of course, we have riparian rights, and we take care that it is kept clean as far as possible, the only pollution that we have to complain of is that of the sewage from a place called Norwood Green, which is turned into this stream.

10366. Above you?—Yes, above us.

10367. But no manufacturers' refuse above you goes into the stream, does it?—We stop them; it has been tried, but we stop them.

10368. (*Colonel Harding.*) You do not seem to realise that there is great necessity for your being stopped pouring in similar pollutions?—Well, I say there is necessity, and I tell you I am perfectly prepared to stop it. The manufacturers' only objection to this action formally of the Rivers Board is that they have never been in a position to tell them what they do want. I can tell you instances where men have spent thousands of pounds, and then been told the whole thing is inefficient. We want to know what will do, and we will do it; but they tell us nothing. They simply say, "Go and experiment for our benefit and our amusement," and manufacturers naturally object to that.

10369. (*Major-General Carey.*) It is very difficult for a Rivers Board to lay down a precise mode; in fact, to take the whole responsibility that the effluent should be purified by a particular mode of treatment, because if they did that, and failed to produce a satisfactory effluent, the manufacturers would say, "You told us what to do; you must take the responsibility"?—I admit it is difficult; but then I think the Rivers Board—my opinion is that they should have experts, who know far more about this question than an individual manufacturer. It would be useful if they had an expert who should give him advice and assistance, and tell him this effluent should be treated in such and such a way from these analyses, and give us such a standard which you have got to arrive at. At the present time matters are in a state of absolute chaos. There is no standard that we have to work to. We have simply to satisfy certain inspectors. One inspector to-day may be perfectly pleased, and to-morrow you may change him, and another may come round, and we have got to do this differently.

10370. (*Professor Ramsay.*) The question is solved under the Alkali Act; for the inspectors gradually brought it about that the works do not turn out deleterious gases in any quantity, and it pays them not to?—Yes.

10371. There has been no undue pressure put on; there have always been the best possible relations between the inspectors and the manufacturers?—I am afraid there are not many of us in Yorkshire would make much profit out of our effluent.

10372. Have you tried it?—No; we would be only too pleased if we could have a man who would show us how to make profit.

10373. (*Chairman.*) Are there any other points you wish to bring before the Commission?—Well, I will just mention two matters. One was that nothing should be done (I do not suppose that anything would be done) to interfere with the existing rights of clean water by giving permission to other manufacturers or local authorities to turn coloured water down the streams; *i.e.*, it would be dangerous if any standard of purity, discoloration, or acidity were established which would make it permissible to return effluent into a stream interfering in any way with existing riparian rights; because if this were legalised the firms located at the head of some streams, being absolutely dependent upon them for clean water, would be ruined. Then, as to clearing out a dam ("slushing" a dam, as it is called in Yorkshire), I understand that there has been a decision that a man has a right to turn into a stream below his dam what is brought by a stream into his dam.

10374. Would you just tell the Commission exactly what your view is as put down in the note here?—It is this: that many men, of course, have not got properly constructed dams. They are simply barriers across the stream, damming it back, and using the water for condensing purposes, or for the purposes of their business. Naturally they are acting as a purifying dam for the stream above. They are catching all the mud or anything that is in suspension coming down. It is deposited in their dam. In the course of time the dam fills up. Well, I say a manufacturer should be allowed in such instances, regularly at stated intervals, to up with his dam sticks and let his stream flow right through, washing down what the stream has brought down itself—what has been in suspension in the water should be allowed to go forward. It has been legal. I think the decision in the Saddleworth case proves that that was the case. It is unfair that he should purify the whole stream, taking everything out of the stream before it comes to him, and then not be allowed to send it on.

10375. But you would recommend that that should be done in a certain way or under certain conditions?—Under certain conditions.

10376. So as not to inconvenience, as you say, users below?—Certainly.

10377. And the determination of that might rest with the rivers authorities?—Yes; I do not see why it should not be provided in the Act.

10378. (*Colonel Harding.*) Would you be willing to leave it to the rivers authority?—It would depend whether you were Chairman of the rivers authority or not. If you were, I have no doubt we should be treated reasonably, but we might have someone else in your place in whom I would have far less confidence. I think there is no reason why the right should not be defined by law. Give proper notice to the people down below—let it be done under proper notice—something of that sort.

10379. You spoke to us just now about the readiness of local authorities in America to encourage establishment of manufactures in their districts?—Yes.

10380. And you have told us of what you consider the admirable carelessness with which they allow their streams to receive trade effluents?—Yes.

10381. But until quite recently, surely that was the case in this country, and it is precisely because manufacturers have been allowed to plant themselves on streams and not treat effluents one after another, that the present condition of things has been brought about, is it not?—As far as the pollution of streams is concerned.

10382. But surely you would agree, would you not, that in the West Riding of Yorkshire, for instance, the condition that has been brought about in our streams and rivers has become so grave that it is absolutely necessary, in the public interest, something should be done to check the pollution of those streams, and if possible, to restore them to something like their original purity?—Well, if that is the ambition of the rivers board, to restore them to their original purity, I am dead against them. I think it is absolutely impossible, and that they may just simply harass industries, and not arrive at any result.

10383. But do you not consider that the condition of these streams has become so horrible, that something must be done?—Absolutely; I perfectly agree. I think that is the gist of my evidence.

10384. Very well. The whole question in connection with these manufacturers' effluents turns then upon whether local authorities should, or should not, receive these effluents into their sewers; the whole thing turns upon that, does it not?—No; I do not think that is the only point.

10385. That is the first thing you have to consider?—That is the most important point.

10386. Can he turn this into the sewer. If so, he gets rid of the pressure of the Rivers board; that is, he ceases to pollute the stream; then the pollution is through the local authority. For instance, in your case, if you are able to discharge your effluents into the public sewer the Rivers board would have nothing further to say to you?—I do not think that question arose in my case; because the riparian right would prevent my turning it into the sewers.

10387. But, speaking generally, the question turns upon this; whether the manufacturer can, or cannot, turn his effluent into the sewer?—Yes.

10388. If he can turn it into the sewer without treatment of any kind the matter is simple enough?—I think you are assuming an impossibility.

10389. If he is allowed to do so?—If he is allowed in certain instances; but I think the riparian rights prevent him turning it into the sewer.

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10390. I say if he is allowed to, that solution is the simplest. I am not trying to trip you up, Mr. Firth?—Let it pass, if you like; but I say you are assuming an impossible situation.

10391. Take for instance, many large towns. Manufacturers' effluents are received into the sewers without treatment of any kind?—They are; yes.

10392. I say that is the simplest way of getting rid of the question?—Yes—in towns.

10393. Therefore the whole question turns upon whether you can, or cannot, turn the effluent into the sewer?—Perfectly; yes.

10394. In other cases local authorities will receive the effluents, if certain preliminary treatment is given to them?—I believe so.

10395. And in other cases again, local authorities will not receive the trade effluents at all?—I am not posted on that.

10396. Well, but surely that is so, is it not, that a great many authorities will not take your refuse?—I can only speak from my own authorities—those I am connected with; I have stated the position there.

10397. You are connected with two authorities, are you not?—Yes.

10398. Are both willing to receive your effluents?—They have neither of them expressed their willingness to do so. One has no sewage system at all; the other cannot decide the matter.

10399. At present they have refused to receive it?—They do not allow us to turn it in.

10400. You speak of the chaotic condition of the law in relation to this matter?—Yes.

10401. Well, the law states pretty clearly that those effluents that do not prejudice the treatment of the sewage, the authority shall receive, provided the sewer is large enough?—Yes.

10402. And the legal difficulty arises, I think you told us just now, in connection with the question whether an authority is bound to make the sewer large enough to receive all the trade effluents?—I did not say so—whether it is bound to.

10403. The legal difficulties were rather in connection with the other point than the prejudice of the treatment?—The practical difficulties, in my own case, are covered by the statement that the sewer is not big enough.

10404. However clear the law might be, do you think it is possible to make legislation apply to all these cases? Must it not necessarily come to this: that each authority must look upon its own merits; you cannot lay down any general rule, for instance, in great cities like Bradford, Manchester, or Leeds. Comparatively small trade effluents may without objection be allowed to go into the sewers, because they probably neutralise each other?—Yes.

10405. And do not interfere with the treatment of the mixed sewage?—Yes.

10406. In another case, for instance, supposing there is an agricultural and residential neighbourhood, and a manufacturer comes and plants a big wool works on the stream in that place, and proposes to turn out a large volume of soapy, greasy water, it is evident that that is a totally different case?—Absolutely so.

10407. So that, whatever the law may be, you are bound to deal with these cases on their merits?—Certainly.

10408. All that the law can do is to lay down some general lines?—That is right; that is what I think; I quite agree with you in that. It is impossible to deal with every case exactly alike.

10409. It is not so much the chaotic condition of the law, it is the absolute necessity. Nothing can be laid down to apply to all cases?—Let me explain. This "chaotic condition of the law" seems to strike you as a wrong statement. What I referred to as "chaotic" is this: that there is no standard that a man may work to; that he is left at the mercy, virtually, of inspectors and a Rivers Board, and that they make some people incur expense, and others not; that the law at the present time is different for the man who has land and the man who has not. If the man has no land round his mill free he is not forced to treat his effluent at all. He can turn it in where he likes. If he has land, however valuable that land may be to him for other purposes, he has got to build tanks instead of utilising that land. I understand that is the law at the present time; and such things as that, I maintain, are wrong; and that is where the "chaotic" condition comes in.

10410. Then you tell us that manufacturers are never told definitely what they shall do to satisfy local authorities; but in many districts they have been told; in a great many, local authorities have laid down certain rules—upon the fulfilment of certain conditions they will receive the effluent into their sewers?—That is a different question, I think. That is as to what the local authority will do.

10411. Yes?—But the question where I say there is no standard, is what the manufacturer has got to do.

10412. Yes; but where the local authority is willing to receive the effluent, the local authority lays down certain conditions, and says if you fulfil those conditions we will receive the effluent. That may not have been done in your particular case; but in a great many cases that has been done, has it not?—I take your statement for that; I do not know what these authorities have done, like you do.

10413. As a fact, a great many authorities have laid down certain conditions upon which they will receive effluents?—Yes.

10414. Does it not seem to you reasonable that manufacturers should conform to those regulations, to their own local authorities' regulations, which, as a rule, are not very exacting?—Well, I think it would be far better if the question of the regulations were not left in the hands of each local authority; but if there was a general standard to work to, and everybody knew what they were doing, and it was treated the same in every district. I do not believe in the power of local authorities to say you must do this and the other to the effluent before they receive it. I would rather have an uniform standard.

10415. It is very difficult to get an uniform standard; but it is satisfactory to have some power of appealing from the decision of the local authority probably?—Yes, that might meet the case.

10416. But in many cases the local authorities have expressed their willingness to receive the effluents if the solids are settled out, if the flow is made regular, and if no deleterious substances are sent down which interefere with the treatment of their sewage?—Yes.

10417. There must be, for instance, no acidity?—No acidity.

10418. Or no acidity which will interfere with the treatment of the sewage on bacterial beds, for instance?—Yes, that is quite reasonable.

10419. Another condition has been that there must be an inspection of the amount—I will say that the authority can get a sample of what passes; all these seem very reasonable and very simple?—Yes, I think so.

10420. And you do not see anything really prohibitive to the manufacturer in carrying out conditions of that kind?—If conditions of that kind are imposed, they would be followed fairly and reasonably by the manufacturers, I am sure.

10421. They should be; in fact, they are not; but they should be so followed?—They would be. Nine men out of ten that you speak to on this subject say they have been bothered by the Rivers Board to do something—to grope in the dark. If they were told what to do they would do it; the better-class of manufacturer would do so immediately, and the smaller ones would have to follow.

10422. But in the great majority of cases they do not want to do anything whatever?—Well, I do not know of any case.

10423. You speak of the want of success of the Rivers Board in causing certain local authorities in your neighbourhood to carry out your works?—Yes.

10424. How long has the Rivers Board been in correspondence with your firm in regard to the purification of your effluents?—I suppose for two or three years.

10425. Might it not be four or five?—I do not think so.

10426. May I ask what, in consequence of their representations your firm has carried out?—The position is this: That we had no land up to last year that we could treat this on. We bought ten acres last year, built some new works for a printing place; and immediately we built the new works we started to build these tanks as soon as we could get men at Brighouse.

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10427. These tanks are being built now at Brighouse?—Yes.

10428. They are actually in course of construction?—They are actually in course of construction.

10429. What are they? Are they what are known as "seak" tanks?—No; seak tanks have been in existence for 35 or 40 years.

10430. For your purposes—obtaining grease?—No; not for the purposes of obtaining grease; we have to pay money to get it done.

10431. What are these for?—To take all our dye-water and printing-water from the new works into these tanks and filter it, and then turn it down the stream until the township puts the sewers down.

14032. And when will these tanks be in operation?—That depends upon the contractor. The contract is let, and he has a lot of men on.

10433. And will they deal with the whole volume?—With the whole volume, certainly.

10434. As regards the other works at Heckmondwike, as the result of three years' representations from the Rivers Board what has been done?—We are in exactly the same position as we were. The local authorities are treating certain manufacturers' effluents—take them into their sewers.

10435. But what has been done at your works at Heckmondwike?—We have seak tanks there, of course. We have had all my life-time, any way; and as far as the dye-water and the milling water is concerned, that is simply turned down the stream which passes our place, and goes into the beck.

10436. But you are not doing anything there?—We are doing nothing.

10437. Nothing whatever?—No; certainly not; why should we, till we know what the township are going to do.

10438. What the Commission want to find out is how the pollution of streams can be stopped by dealing with these trade effluents?—Yes.

10439. And we rather look to a firm of the eminence of your firm to set an example to others. Could you assist the Commission, and show us that you are doing something, or that you are proposing to do something?—I think I may ask that of the Commission.

10440. But here at Heckmondwike you are doing nothing?—At Heckmondwike we are perfectly prepared to put down our own tanks if we know that the local authority is not going to take in manufacturers' sewage into their drains.

10441. Then there is a doubt there whether they will take it?—Yes.

10442. But, meanwhile, should you not put down these settling tanks, which they are sure to require?—No; but I do not know that they are sure to require them; I do not think they are sure to require them at all.

10443. You think they would receive this without any previous treatment whatever?—I say at the present time they are receiving other manufacturers' trade effluent without any treatment whatever. Now, we are the largest ratepayers in the place; if they are receiving other people's, we have the right to ask them to receive ours; because ours is not nearly so bad as those of certain size works they are taking there. As soon as they make their position clear that they will take no manufacturers' effluent, except it conforms to such-and-such a standard, we will conform to that immediately.

10444. You will conform?—Yes, certainly.

10445. Then we may take it from you that you think it reasonable as a large manufacturer yourself, that where conditions are laid down by local authorities, previous to receiving the effluent into their sewers, that manufacturers should conform?—You are stretching a little bit. If conditions are laid down; if reasonable conditions are laid down. We would not like to leave it to any little local authority to say what we should do.

10446. (*Professor Ramsay.*) Who should determine that the conditions are reasonable?—You gentlemen; legislation should settle conditions that are reasonable.

10447. But then comes the difficulty, for they must differ in every case. Would not that be argument in favour of some sort of permanent board to settle such a question?—They differ in every case.

10448. In many cases they differ—the conditions might differ?—The conditions differ or the local authorities differ.

10449. The conditions differ—the conditions are different, of course, in many cases.

10450. Therefore you cannot very well fix a standard, owing to these different conditions?—Oh, I think you could. You might fix a percentage of solids and acidity; that might be done. Let the local authorities, if they like, propose conditions as to the working, the flow, and the inspection, and so on. But I think there should be a protection for the manufacturer when he puts these tanks down, that he is not to be told, "It has just 1 per cent. too much solids," or "1 per cent. too much acidity." He should know what he has to get at, and work to that.

10451. (*Colonel Harding.*) That is a matter for the local authority; it is not a matter the rivers authority can lay down?—I do not think it is a matter for the local authority.

10452. The Rivers Board cannot say, "We shall receive on these conditions." It is a matter for the local authority, not the Rivers Board?—I do not quite agree with you that it is a matter for the local authority or the Rivers Board. I would make it the law of the land that such and such condition of effluent is all right, that the manufacturer is barred from proceedings either from the local authority or the Rivers Board if it is of such a condition. I would make that the first proposition. Then as to the working of that, I would leave that to other people to say how that should be done.

10453. But do you really suggest to us that it would be possible for the law to lay down some standard that would be universally applicable to all trades and all streams?—No, I do not say so; but there should be a minimum; that is to say, there should be a standard fixed that a man can do better if he likes, but they have no right to turn into the stream, except in such-and such a condition. Beyond that they must turn it down sewers—something of that sort.

10454. Then, as a large manufacturer, what do you say to us in this matter; you agree that the condition of the rivers is becoming too atrocious to bear?—Certainly.

10455. You agree that there is a responsibility on manufacturers to do something to purify?—I do.

10456. And that it would be reasonable for them to comply with the requirements of local authorities in most cases, and where the local authority will not receive their effluents at all, that they should then be called upon to do something to purify effluents themselves?—No; you are going a little too fast.

10457. Do you say that in those cases they should not be called upon to do anything?—In the first place, I do not agree with you that the local authority should be in a position to prosecute an individual manufacturer. I think that in nine cases out of ten the local authority know very little about it, and I do not believe in putting so much power in the hands of these small local authorities. I think you would not either, if you had had the experience of them that I have had. What I consider right is to fix a national standard to work to.

10458. Tell us how these streams are to be purified. The local authorities are not to lay down conditions of its own; I did not gather from you that the manufacturer is going to do anything or ought to do anything?—He ought, most certainly.

10459. Then, what is to be done to purify these streams?—I think I have been all the time saying what I think should be done.

10460. All I gathered from you was that he might properly be called upon to settle solids?—He ought to take solids and acidity out to a certain standard. As far as my experience of manufacturers in Yorkshire is concerned, we are prepared to conform to a reasonable standard, if we consider it so.

10461. Do you think manufacturers should be

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allowed to turn into a stream any effluent from which solids have been removed, and it is in a neutral condition?—Certainly, I do.

10462. However foul otherwise?—I do not see that they can be very foul if those conditions are imposed.

10463. (*Professor Ramsay.*) It might be very dark coloured?—Well, discoloration is no pollution. I do not think it ever will be. If you are to take the colour out, you are imposing an almost impossible condition on manufacturers, and I know heaps of dyeworks would have to move altogether. I do not see that discoloration is deleterious to public health.

10464. Well, it depends. It might prevent the stream from ever purifying itself. Supposing there were sewage went into the stream at the same time, as a matter of fact it might never purify itself?—Yes, well, of course, that is a matter I cannot deal with. I am not an expert on the subject, but all I wanted to state is that manufacturers are perfectly ready, the majority of them are perfectly ready to do what is necessary to help to purify the streams as a national advantage, an advantage to the nation at large, if they know what they are to do, but they do object to being called upon to experiment and work in the dark.

10465. (*Chairman.*) Certain lines are to be laid down by legislation, and the local authorties are simply to see that those are carried out, but not lay down the lines themselves?—Not to lay down the standards. I think on questions of manipulation, they should have the right as to the flow, as to the inspection; Colonel Harding says it is necessary. I consider it is perfectly right, and you cannot prevent them having that.

10466. (*Colonel Harding.*) Do you mean to say that the Rivers Board and the legislative ought to tell manufacturers precisely how they should conduct their business in this particular matter?—No.

10467. Or to come down to them, and say: "You must purify your effluents by this or that process"?—No.

10468. Would that be fair; is it not better to leave Messrs. Firth to do that in the way they think best, provided they stop the pollution?—I think you are mixing two points which I raised. One is as to the condition of the law at present, that the Rivers Board should say what we are to do, either give us a standard to work to, or do it in this way; but what I am saying to you generally is, that I would make it the law of the land that they have got to get to a certain standard. Then the question as to the Rivers Board telling us what to do does not arise; each man must find out for himself. We are told to do anything; build tanks; "let us see you build tanks," throw thousands of pounds away—"It does not matter; let us see you are spending money."

10469. Who tells you that?—That is what it simply comes to—"Put down tanks." We do not know whether it will satisfy them when we do that; we do not know what to work to. They say: "Build tanks; go on, do something; build something."

10470. That is not quite the way the thing is put. You are simply told to stop the pollution. It is left to you to do it by tanks, or otherwise, as you may think fit?—That is right; but, "let us see you spending money, and then it is all right."

10471. You told us about the people who foul the stream above you, that you take good care to prevent them from doing so?—Yes.

10472. Well, how do you prevent them; what do you call upon them to do? Do you tell them exactly what they should do, or do you simply say "stop this"?—No, it is not our business.

10473. What do you say to those people above you; you said you had control over them?—We say "we have a right to a clean stream. We are using that. We shall sue you if you foul this stream, turn sewage into it, or turn discoloured water into it."

10474. Why should not those below you deal with your firm on exactly the same lines?—Because the case is totally different; they have built their works since the stream was polluted, since the stream was discoloured. They would not think of putting dyeworks or printing works on that stream after we have used it. They would build somewhere else where they would get a water-right. The case is totally different. What has existed now for 50 or 60 years, and what a man is to take from you, that is a totally different question.

10475. I am afraid we cannot get further than this, that you think in the abstract that manufacturers ought to do something; but, apparently, it is not very much that they ought to be called upon to do?—I beg your pardon. I do not think it is not much. I say that the manufacturer is perfectly willing, as far as I know, most of the men—my friends are perfectly willing to do anything in reason to purify those streams. They recognise that it is a national advantage that they should be purified; but they object to people telling them the stream is to return to its virgin purity. They want something reasonable, and some general precautions establishing, that they have got to adopt—work to a reasonable standard.

10476. I saw a stream lately which, on entering a dye works, was perfectly pure; there was nothing about it—it was just the ordinary mountain stream. It left those dye works in a most shocking condition—an appalling condition. Now, what would you do with a manufacturer of that kind?—Well, in what condition was it? Was it discoloured or polluted?

10477. It was polluted in every possible way. It was discoloured so as to be absolutly opaque, and there was a great deal of solid coming down with it, and the stream could no longer be used for manufacturing purposes?—I suppose the man had acquired the right to discolour this stream.

10478. Had gone on doing it probably for a number of years?—Yes, and it would make no difference to anybody.

10479. Would you not expect him to do something; something to be done to purify that stream?—I would expect him to take his solids out.

10480. But nothing more?—I think he could not take his discoloration out without very considerable expense.

10481. If he turned out an effluent which was coloured, but contained a great quantity of dissolved organic matter, you would not stop him, or dissolved chemical matters which would prevent the use of a stream lower down?—Will prevent the use of that stream lower down for dyeing purposes?

10482. For general purposes or for dyeing purposes?—Nine out of ten men would rather have discoloured water for their boilers. The use of it takes the hardness out of it, which prevents scale in the boilers.

10483. In specific cases?—In many cases. The man below, say, would rather have that discoloured water after it has been used, because it has taken some of the hardness out of it.

10484. (*Chairman.*) Then you approve of the words of the Act: "Polluting should not include innocuous discoloration"?—I do, most certainly. I think that is only a reasonable safeguard. If these words were removed, it would mean a most serious matter to most industries in Yorkshire at least, all the manufacturers of the better class of goods dyed or printed.

10485. (*Colonel Harding.*) Just one other point. Suppose a perfectly clear stream in an agricultural or residential district, and a person proposes to establish a manufactory, which will turn out all this quantity of dye water, do you not think it fair to call upon that manufacturer to consider the purification of his effluent, as part of the expenses of his business, and to call upon him, before starting his manufactory, to have at work the necessary appliances to prevent pollution?—Has not that landowner adjoining that stream the right, at the present time, under the existing law, to prevent him?

10486. He could not always do so; there may not be one landowner controlling the whole stream. It may be a great number of small landowners?—But any one individual has the right to prevent a man coming and establishing a works in front of his residential place, and discolouring the water which passes through his property.

10487. Have these rights been exercised? If they had been, our streams would not be in the condition in which they are?—They have not been exercised in the past, but I think they would be in the future. I do not think that is a point that we have anything to legislate afresh over.

Mr. HENRY BEAUMONT, called in; and Examined.

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10488. (*Chairman.*) You are a fulling miller and finisher, of Elland Mills, Elland?—Yes, sir.

10489. Can you state the quantity of trade effluents you at present discharge into the River Calder?—About 10,000 gallons daily.

10490. What are the features of that effluent?—Just scouring the grease out of the cloth by alkali and soap. The oil that is put in from the manufacturing has to be scoured out before it is properly finished.

10491. Then, what are the main constituents of the effluent; could you describe it briefly; how it differs from water?—By containing grease and alkali.

10492. A large quantity of alkali?—No, it is just sufficient, what we may call, to make a scour; we should ordinarily use soap in washing out any greasy material.

10493. You are fairly well acquainted with a large number of textile mills discharging their trade effluent into the Calder and its tributaries?—Yes.

10494. And the various modes of treatment adopted; do you yourself obtain water from the Calder?—Yes; I filter it first; I have to filter it before using it.

10495. The whole of the water which is used in your works is obtained from the Calder?—No; occasionally I have to use town's water.

10496. What proportion of the latter supply do you have?—It varies largely from the material that we have to work, and also on the state of the river,. We use more in the summer time, when the river is more filthy, than when there is a fair supply of water in the river.

10497. Could you state very broadly limits of variation?—No; it varies entirely.

10498. Sometimes you use half from other sources than the Calder?—Oh, no; never half; if the thing is in order, never half.

10499. But when the stream is very dry, for instance, what is the maximum proportion?—If we have a large quantity of white goods, then we have to use more of the town's water, but it is not a large quantity out of 10,000 gallons a day; it would not be a large quantity in the dryest time, because many of the goods are grey.

10500. Perhaps one-fifth or one-sixth?—Perhaps one-fourth, but that is only in that time. Of course, the filter—we have to filter the river water—is rather expensive, but it is cheaper than town's water.

10501. It is cheaper to take it and filter it, than to take town's water direct?—Yes, during the ordinary flow of the river.

10502. (*Mr. Power.*) You have to pump it?—Yes.

10503. (*Professor Ramsay.*) You filter it through sand, I presume?—No; it is a filter composed of charcoal in layers. We just force the water through that into a large boiler cistern, an old tank, an old boiler used as a tank, and it gets it fairly cleared. Of course, we have to clear the filter out pretty often; the tank has to be cleaned out as well.

10504. (*Chairman.*) And the riparian owners below your mills have power to compel you to return the water to the stream again, have they not?—Oh, yes; they have the power, but there is practically no one using it below our mill. When it is turned into the main sewer, it gets back into the river again. There is no water power from our mill to where the effluent from the sewage works gets into the river. There is practically no one to complain.

10505. Are you satisfied with the definitions of the existing law, as to the relative position and rights of manufacturers and local authorities?—Well, it is rather a legal question; I am not exactly satisfied, because some local authorities are rather different from others; some will take our trade effluent and deal with it, while others will not; they vary.

10506. Do you think that the law should be altered so as to give manufacturers greater rights than at present to connect up with sewers?—I think it ought to be that they should have a right to connect with the sewers.

10507. Under all circumstances?—No; after taking out the solids.

10508. Is that adequate security, taking out the solids?—Well, in cases where they have a sewage works they will be able to eliminate; take the other out afterwards.

10509. Yes, but might it not be the case that after you have taken your solids out, there will be substances in solution in the remaining effluent which, mixed with the sewage, might seriously interefere with the purification of the sewage; might lead, for instance, to precipitation as to solids, which would interefere with the work of filters and so on?—I do not think so; as far as our district is concerned, the treatment of the Elland Urban District Council.

10510. And, of course, you would exclude, I suppose, with the solids, too great acidity, or alkalinity?—Well, I do not see how you are to take out the acids.

10511. Would you think that the manufacturer should have a right to discharge into a sewer an effluent from which he had removed the solids, if there were a very large amount of acid left which might interefere with the process of purification, bacterially or otherwise?—Seeing that the manufacturer has to contribute very largely to the cost of these works, it is only right, in my opinion, that the council treat his effluent after he has taken out the solids.

10512. The conversion of the acidity should be with the local authority, and not with the manufacturer; that the manufacturer should be compelled simply to remove the solids; is that your position?—Yes, that is the position I take.

10513. Do you think any other safeguards are required to secure that the refuse shall be delivered in such a condition as shall be consistent with the purification of the sewage, and in particular, that it shall be delivered in such regular quantities as not to interefere with the purification, because it is very obvious that the same works would not be competent to deal with a very large quantity flowing in one hour, and a very small quantity flowing in another?—No, well as far as my experience goes, of the manufactories in our district, the effluent is practically continuous. If there is one machine emptying at one time, and another at another, or washing off, you may take it that it is distributed fairly over the whole working hours. I do not think there is any great extra flow at any special time.

10514. So that the question does not arise in connection with your works?—No; not so far as I am aware.

10515. You see no difficulty in the local authorities having an inspection chamber by which they can examine?—I think it is desirable that we should all be on a level.

10516. Then are there any other safeguards required, do you think, and how would they best be enforced?—I do not know that there are any special safeguards that are necesary for our district, except keeping out solids.

10517. Would you say that manufacturers generally are prepared to adopt means for the removal of solids?—Yes, and throughout our district quite willing to adopt what they consider reasonable means to do what they can to meet the requirements.

10518. Then in the case of a local authority refusing to allow the trade refuse to go into a sewer, do you see any advantage in some central tribunal, to which an appeal could be made?—Yes; I think it very desirable.

10519. Did you see the interim report we issued some little time ago?—No, I did not.

10520. In which we recommended a supreme river authorities, a department of Government, for dealing with these questions, and being the court of appeal?—No; I have not read that.

10521. But that would meet with your approval?—Certainly.

10522. Then do you think that manufacturers should be required to pay a special rate or charge in the case in which they are allowed to connect with the sewer?—No, not any manufactory at present existing in those districts. The only case I would see, is where a manufacturer goes and plants his works where there is practically a pure stream. It would, I think, in that case, if the authorities have to deal with it; he should pay his fair proportion in establishing new works.

10523. Can you make any general statement as to what are the main difficulties which arise between the manufacturers and the local authorities; what, for instance, are the general reasons advanced by local authorities for refusing to allow trade refuse to go into the sewer?—Well, I often find, on looking at the consti-

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tution of these councils, that they are composed of men who have not a large interest in manufactories, and, in fact, they do not see why they should help the manufacturer to treat trade effluent.

10524. But the reasons alleged, I mean. Is it that the sewer is not big enough, or that the trade refuse would interfere with the system of purification adopted by the authority?—In our district it is large enough to admit of the trade effluents; we have no difficulty in that respect. There may be some where it might interfere with the bacteriological treatment, but I am not sufficiently versed to go into the matter where the trade effluents might interfere somewhat.

10525. The difficulty, in your opinion, arises from the constitution of the local authority?—Sometimes.

10526. And that could be met, I suppose, by a tribunal, as suggested just now?—Yes.

10527. Then what, in your opinion, would be the effect upon the flow of water in the streams if the trade refuse were diverted from them and taken into the public sewers?—Well, in some cases it would be very serious; in our district it would. There was a scheme by Mr. Paskin to take the Halifax sewage and trade effluents in a large sewer all the way past us at Elland. If they did that it would deprive the Elland Mill of a large quantity of water, and not leave enough to turn the water mill, and would become a serious matter.

10528. And that applies equally well to dirty water as to clean water?—Precisely the same.

10529. Are there any other points you would like to bring before the Commission?—No, I do not know of anything special.

10530. (*Colonel Harding.*) What is the authority with which you have to deal?—The Elland Urban District Council.

10531. Has that district council agreed to take manufacturers' effluent?—Yes, they have made provision for them.

10532. Can you connect up with the sewer?—Not yet. I am expecting to in about two or three weeks.

10533. Has the authority laid down any conditions which you have to fulfil first?—Yes; take out the solids.

10534. And are you fulfilling those?—Yes.

10535. Are the works established?—We are extracting the grease, and then there should be sieving for taking out flocks.

10536. But the conditions have been laid down by your district council?—Yes.

10537. Are you complying with them?—Yes. Just the same conditions as the others above the stream. There are a lot on this stream just turned in from the machine, after the grease has been taken out by the extracting, that goes into the tanks.

10538. What other conditions have they laid down; that you shall withdraw the grease?—Take out the heaviest part of the grease.

10539. And the solids in addition?—Yes.

10540. Are you putting down tanks, or what are you doing?—I have not done anything yet; it is only under the consideration of the council.

10541. As a fact, you are doing nothing?—Not till I get their consent.

10542. But I understood they have given their consent?—No, it is under consideration; it is practically in committee.

10543. I rather gathered just now that you said that your authority had agreed to take trade effluents on conditions?—They have taken trade effluents from other mill owners, on the stream above Elland Mills, and are taking them; they are also taking the trade effluents from the mills in the district, which are communicating with the drains.

10544. Then in your particular case it is settled that they will take your effluents on conditions?—Well, I am not in a position to say that, because it has to be confirmed. It is in committee. They were down about a fortnight ago to look at the place.

10545. And so, if they agreed to take it on conditions, you are prepared to fulfil those conditions?—Certainly.

10546. And you think it reasonable that manufacturers should undertake to fulfil reasonable conditions laid down by local authorities?—Yes, reasonable conditions.

10547. And, speaking generally, you think the remedy for this pollution is that local authorities should, as far as possible, receive effluents into their sewers?—Yes.

10548. You think it is easier for a local authority to deal with pollution in effluents than for an individual manufacturer to do it himself in each separate case?—Yes, much more easily, and they can do it at less expense than individual manufacturers can.

10549. But, clearly, that would be more easy for a large authority than for a small one?—Yes.

10550. You do not think it would be possible to lay down any general line, as the compelling of local authorities to receive trade effluence?—Well, no, not all local authorities.

10551. Cases must be tried on their merits?—There may be exceptions; there may be exceptional cases where it would not do.

10552. What would be suitable for a great city of 400,000 inhabitants might not be suitable for an agricultural district, on which there was, for instance, only one individual firm turning out a very large volume of trade effluent?—No; they would be quite different in the case of treating it.

10553. Then, in this case, where it would be reasonable for an authority to refuse to receive an effluent, would you consider it right that the manufacturer should be called upon to lay down purification works himself?—Well, I scarcely understand.

10554. Well, where the authority cannot or will not receive the effluent into its sewers, what do you suggest should be done to stop the pollution?—Then the tribunal would come in that we have already been speaking about, to decide whether it is reasonable or not.

10555. Supposing the tribunal decides it is not reasonable to be received into the sewer, would you then call upon the manufacturer to do something towards the purification?—I do not see there is any other chance; there is no option to the manufacturer if they refuse to receive it, and the tribunal decides against him.

10556. And he would have to put down some purification works himself?—I do not see any alternative—or give up.

10557. To what extent, then, would you call upon him to purify his effluent; merely to the extent of the solids?—It would depend on the circumstances of the stream altogether; I could not go into that minutely.

10558. Your position is that you cannot lay down a general rule applicable to all cases?—No.

10559. In settling the grease in your works, you do not think it practicable to settle all the grease; it is only the thickest part that you settle?—That is all.

10560. So that from that process of sediment—is it a seak tank?—Yes.

10561. From the seak tank one expects to get a considerable amount of grease into the effluent after you have done all that you can to withdraw?—Yes. We take the thickest part out; there will be some quantity, not a large quantity, of soap or grease left in.

10562. Do the manufacturers in your neighbourhood show their willingness to put down the necessary plant to fulfil the conditions of the local authority in your district?—Well, yes, I think they do. I have found, generally speaking, willingness on the part of the manufacturers to adopt reasonable precautions, or reasonable measures, for keeping out the solid matter and the grease, as far as they can.

10563. And you expect very shortly it will be definitely decided by your authority whether they will receive?—Yes.

10564. And then yourself and the manufacturers in your district will be willing to put down the necessary plant to fulfil the conditions?—Well, most of them are already connected; I am practically the only exception on the river that is not already connected.

10565. Yours is the only exception?—On the river.

10566. That is not connected with the sewer?—Well, there is one—yes, there is another. There is no chance of connecting with the sewer, because there is no sewer goes past the mill, but there are three or four dye works and woollen mills above me, all connected with the sewer from the first.

10567. (*Major-General Carey.*) Do those manufacturers who deliver their trade waters into the sewers

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make no special contribution?—They think they pay very heavily in the rates, quite sufficient to entitle them to the sewer. Most of the factories are very heavily rated where this trade effluent is turned out, and, of course, they pay a fair proportion of the cost of the works in the form of rates.

10568. (*Professor Ramsay.*) Is the water that reaches you coloured?—Oh, yes; very much discoloured.

10569. Does that interfere with your processes?—Yes, we have to filter the water.

10570. Is that sufficient to take out the colouring matter?—Well, it does largely; it takes the colouring matter out largely. The state of the river is very bad at times, in the summertime especially; we have to filter it all the year round for scouring purposes.

10571. Are there dye works above you?—Oh, yes, largely.

10572. You do not contribute to the discoloration of the water, you merely mill your goods?—Yes, merely the scouring processes; not discoloration from dye.

Mr. JOSEPH CROWTHER, called in; and Examined.

Mr. J. Crowther.

10573. (*Chairman.*) Mr. Crowther, you are chairman of the West Riding of Yorkshire Millowners' and Occupiers' Association?—Yes, I am chairman.

10574. And you are in the Huddersfield trade?—Yes.

10575. Might I ask what are your own works?—Well, I have every kind of works. I have both woollen and worsted spinning and cotton spinning.

10576. Are these all at Huddersfield?—All in the neighbourhood.

10577. Then you discharge a considerable quantity of trade effluent into the stream there?—Yes.

10578. Into one stream or more than one?—Well, into more than one stream, because the works are around Huddersfield, though not all on the same stream.

10579. Can you state roughly the amount of trade effluent you discharge into the stream?—Both dye water and scouring water; altogether, I should say, at the different places, probably 150,000 gallons per day.

10580. Per day?—Yes, at all the different places; there are six places.

10581. And what is the general nature of the trade effluent? What are its chief features? What does it contain besides water?—The scouring, of course, contains alkali and soap.

10582. A large quantity of soap?—Yes, a fair quantity.

10853. A large quantity of free alkali?—Yes, a large quantity of free alkali.

10584. Can you make any statement as to the amount of alkali?—I could not go into that chemically—no.

10585. Any discoloration of the water?—Yes, considerable from the dyehouse.

10586. It is very deeply discoloured?—Yes; all the Colne Valley water, when it gets down to the lowlands, is very badly discoloured.

10587. (*Professor Ramsay.*) Does it reach you in a discoloured condition?—Yes.

10588. (*Chairman.*) Do you obtain your main supply of water from the streams on which your mills are situated?—In some cases we do, but not in all. We get our clean water, for scouring purposes, from the canal, at two of the places.

10589. What is the proportionate amount of water that you get from the canal, or otherwise, and not from the stream?—I could not give you that, it is not measured.

10590. Is it one-half, or one-tenth, or what?—Well, I should think in some cases it might be one-half, in other cases not so much; it is not measured from the canal; the system upon which we take water from the canal is by means of a pump, working at a certain speed, and we can draw as much water as the pump will lift, and we have never measured it; it is not paid for by measurement.

10591. But as regards the water that you take from the stream. I suppose the riparian owners can compel you to return that to the stream?—There is no doubt about that.

10592. Then may I ask you your opinion as to whether the relative positions and rights of manufacturers on the one hand, and local authorities on the other, are satisfactorily defined by the existing law?—No, I do not think they are clearly defined.

10593. May I ask what are the chief difficulties that are met with on the part of the local authorities to taking your refuse into a sewer—Is it that the sewers are not big enough, or that your trade effluent interferes with the purification of the sewage when so admitted?—Well, unfortunately, they decline to take it where they have got no works.

10594. They cannot take it?—They decline to take it where they have got no filtration works, but where they are constructing them, and where the sewers are large enough, so it is not on account of the quantity or the character of the trade effluent. I have been on the Urban District Council of Golcar and Marsden ever since I was 21 years of age, and first of all, I should say there is doubt as to whether it is the duty of the authority—with most of them, to admit trade water into the public sewers, the law being so unsettled. That would be one of the first reasons that I should give. The next reason is the reluctance of the authorities to increase the burden of their responsibilities. Then another one would be a desire on their part to throw the responsibility on the manufacturer, without reference to the interests at all of the industry. All these obtain in a great many places; there are places where they do not obtain, but in our own valley they obtain at present. Then the want of better knowledge and information as to how to deal with the sewage problem, there having been so much capital expended on sewage disposal works throughout the country, which works are now considered inefficient. If you take Mr. Tatton's evidence, which you have had before you, you will observe that, out of 398 works constructed in Lancashire, 144 were declared to be not efficient. I was upon the County Council for three years, and during that time works that we passed, and thought would be efficient, are now not efficient. Dr. Whitelegge had to do with these personally. I have been to lots of places. I have visited many of the important works in the country, and I have gone into it carefully from a manufacturers' point of view, to try to devise some scheme which would come within a reasonable cost, that could be put down.

10595. That is to say as to which of the systems existing in various places would be best suited to take your refuse in?—Yes, as to what would be best. In every case, with the information which has been supplied to us by Dr. Wilson, all the places that he has thought satisfactory we have gone to see, and you would see from any one of the reports, if I were to give you any one of them that we have compiled from the statement that was given us by the manufacturers there, how much they differed from the notions that the river board has got of them. In one case where Dr. Wilson told us distinctly that they were making profits from the works, the principals themselves—we got all our information from the principals—the principals showed us what a considerable loss there was every year, and even then he was bound to confess that it was not satisfactory.

10596. These I understand are reports?—These are reports of the separate works visited.

10597. When you say we?—I myself personally visited, but in all cases there have been two or three manufacturers. I have not gone alone.

10598. And you have examined the question from the manufacturers' point of view?—I have.

10599. And you found, do I understand, a want of coincidence between the statements of the local authorities and the statements of the manufacturers themselves?—Yes, that is so.

10600. (*Mr. Power.*) But are these works pointed out by the manufacturers themselves, or works picked by the sanitary authority?—They are works which were in many cases pointed out to us, or referred to, by the officials of the Rivers Board.

10601. Constructed by the manufacturers for dealing with their own sewage?—Yes.

10602. Before passing it into the stream?—Before passing it into the stream, but these have been adopted

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almost invariably under pressure, either from the riparians' point of view, or from the Rivers Board.

10603. (*Chairman.*) But the main result, may I take it, Mr. Crowther, is that it has been a much greater cost to the manufacturers than what appeared from the statement of the local authorities?—Yes, very much greater.

10604. That is your main point?—That is the point I want to bring out—yes.

10605. Would you have any objection to putting in evidence either of these reports, or such analyses of them as you think would bring out the points you desire to bring before the Commission?—If I do I have to drag somebody else in, but that is a thing I do not want to do, and that is a difficulty we have in getting Dr. Wilson to realise exactly the real state of things. Over and over again, I have wanted to have an interview, but what we have felt has been that the Rivers Board is keeping too much aloof from us, although Dr. Wilson himself has treated us very well up to a point, but beyond that, of course, we could get no further. We could neither get a standard, nor could we get the slightest satisfaction, that if the best works were put down, and money was spent upon them, that they would be considered satisfactory for any length of time. We can get nothing, and that is just where the whole trouble comes in; and if the evidence we are giving before the Commission leaves us where we have been left by the Local Government Board, the whole position will still be unsatisfactory. I do not hold a brief for the manufacturers—not one bit; I am trying to speak of the thing from both sides, as I understand it. I have gone carefully into it, and my brother with me. We have lost no opportunity in trying to get at something definite. The moment we could see something we would advise the manufacturers to go into it, and they would do it if there was likely to be no difficulty about the outlay. But it is absolutely impossible for the trade to spend an outlay of £1,000,000, and then be called upon to expend another £1,000,000 to reconstruct and alter. The last time I was taken into Court in connection with these mills we were fined £60. Dr. Wilson stated 'I know you could do the whole of this for £800.' I said, 'I will give you a cheque now, before we leave the Court, for £1,200, if you will undertake to rid me of this, and make a bad debt of it.' But it is not everyone who is in that position. We have had cases of manufacturers who have applied to the bank of which I am a director to increase their overdraft for the purpose of constructing purification works, and these are small matters you may say, but still they are very important; they are important as affecting small industries, which have been established by men who have very little means. There are cases that I know of where one man was threatened with proceedings by the Rivers Board. His bank account had worked fairly well; he was only in a small way (a dyer), and he had to borrow £600. It is three years since he borrowed this money. His bank account has never been so satisfactory since, and he has got to struggle with it. Of course, there is only the one satisfactory remedy, and that is by means of the local authority. I do not see how it was possible, for instance, to cleanse the dye waters. It is impossible to do it. You may, by a process, long enough, cleanse, if you were to send it down a stream, probably at the rate of four or five miles an hour.

10606. By cleansing, do you mean removing the colour?—Yes, removing the colour. The colour is the worst factor, that is, the worst thing you have to contend with. If it had to run long enough out in the open, I should think that in about five or six miles' run in the open stream, over the pebbles, you can remove it to a very great extent.

10607. By oxidation?—By oxidation, to a very great extent, the discoloration, and also the grease and solids. If you take the Public Health Act, 1875, Section 21, I think it is beyond all doubt it was the intention that the local authorities should deal with every kind of sewage, because when you get further on, and you come to a definition of the premises, you find that factories and everything are taken in. It does not matter what kind of sewage it is; but when you come to the Rivers Pollution Prevention Act, 1876, Section 7, then you find it begins to whittle it down. Then the powers that are there prohibit liquid, which would prejudicially affect such sewers. Well, that ought to be out, "or the disposal by sale of the sewage matter." Well, this is a sufficient shelter for any authority, and so on that account will not take it in; for, as a matter of actual experience, this sewage matter has not the slightest value for land, and the same with the three clauses, "or application to land or otherwise." That is no good. Those ought to come out. The fourth is all right, "Which would, from its temperature or otherwise, be injurious from a sanitary point of view." Then 5, "Where the sewers are only sufficient for the requirements of the district." Well, it should be the duty of the local authority to construct sewers of sufficient dimensions. It is not a hardship; it cannot be a hardship. Take towns like Huddersfield. Huddersfield has laid out something like £350,000 upon sewage works. They have taken in every manufacturer who has applied to them to go in. They took in at the beginning the whole of the water, the whole of the fresh water, and now what have they got to do, after putting down an enormous intercepting sewer the whole length of the borough? They have to take and provide for every particle of this fresh water being taken out purposely to keep the drains, as they thought, in better condition. The result is that they have got to lay a duplicate system for the fresh water almost throughout the town.

10608. Then you are arguing that there is need for a fresh definition of the law?—Well, I think that it ought to be so clear that the local authorities are bound to take it, not that they may take it. There are cases where it may be necessary, as in the Batley Beck, which Colonel Harding knows about. There are lots of cases where the riparian owners would object to its being put into a sewer, because he requires the water. There would not be any, and the result is that they must be allowed to use this water till they can get it to such a point where they can treat it. It is just as much in the interests of the Rivers Board as it is in the interests of the manufacturers, that the trade should not be put to any undue expense. We do not want in any shape or way to interfere with the industries that we have got established, and if that is so, the local authority, whatever it be, whether it be a county borough or an urban district council, ought to take the responsibility. Then the Rivers Board ought to look after the local authority; but to have two or three authorities in one district is beyond all doubt harassing to the trade.

10609. You are now dealing with the nature of the authorities?—Yes. Then there is another matter; you have got five Acts in connection with the Public Health and the Rivers Pollution. The Public Health Act, the Rivers Pollution Prevention Act, 1876, the Public Health Amendment Act, 1890, the Rivers Pollution Prevention Act, 1893, and the West Riding of Yorkshire Rivers Act, 1894. Well, those would be very much better if they were consolidated.

10610. As the matter stands at present, do you think it is desirable to so alter the law as to give manufacturers greater rights than at present to connect up with sewers, or do you think the present law is adequate?—I think the present law, with these clauses omitted that I have read out, would be adequate.

10611. Do you think that any further safeguards than those already provided are required to insure on the one hand that the refuse should be delivered in such a condition, and on the other hand in such regular quantities as not to interfere with the purification of the sewage?—Well, any further safeguards, as it is put there, I take it means above and beyond existing safeguards. I think that is really what you meant by this question?

10612. Yes?—Well, I do not think that any further safeguards are needed, because if you create to-day as many safeguards as ever you like, you should have them as clearly defined. Keighley has got a list here which they have made for their borough. Dr. Wilson gave us a list for the Holmfirth district; they were both excellent, but neither of them would meet every case. For instance, at Earlsheaton, where they have quite a different class of matter to deal with, that is Fuller's earth, the conditions vary so entirely that whatever authority has the power to make this arrangement with manufacturers, it ought to be an arrangement made between the two without a mass of harassing conditions and regulations, provided either by Act of Parliament or anything else. The more you provide I am perfectly certain the more trouble you are causing hereafter. I think the more simple you can leave the whole of this matter in legislating, and trust the authorities absolutely in the same way as you have to do to-day with the Factories Act, the better. With the Factories Act we found you could not define what a factory inspector could do; but if the factory inspector can make out a

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straight case, the law supports him, and I think you ought to leave local authorities very much in that way; you can define what you like, and you will find conditions will arise that you have not provided for.

10613. Yes, of course, it is so; is it not that there are certain results which ought to be common in all cases where a certain amount of purification is required?—Yes.

10614. But the method by which it is arrived at is that the point that you are wishing to put before us, that the method by which the purification should be arrived at should be left to agreement between the local authorities and the manufacturers without being harassed by any particular legislation as to the method?—Quite so; you cannot provide legislation to meet it; you can provide legislation which will harass the position, but which will not meet it. We have a case here—the Greenfield Mill Company, probably Colonel Harding may know about it, but these were bleaching works which were established, and they are established unfortunately at the head of the stream, and they turn out about 400,000 gallons per day; and with the best known means available it is impossible, absolutely impossible, to deal with either the quantity or material that is put into it. And the result is that he has to make the best arrangement he can with the riparian owners below, and that is one of the things the authorities would have to leave the manufacturers to do to-day. He is providing the best available means that he knows of, but when he has done it, the people below would have had to close the place altogether if they had not been able to make an arrangement that he should supply them with clean water, and he has laid the pipes on, and when it gets lower down still, it gets so much better they can use it for cleansing purposes. These are cases that are arising.

10615. (*Colonel Harding.*) We understand in that case the manufacturers turning out this large amount of effluent piped down the pure water to the people below?—Yes, he piped it down so that they could have clean water.

10616. By sending pure water down?—Mr. Butterworth knows about it. He is the gentleman who receives that pure water.

10617. (*Chairman.*) This you quote as a special instance of special arrangements to meet special cases?—To show you could not provide for cases like these. I could give you others in the same way.

10618. The gentleman who preceded you seemed to be of the opinion that all that it was needed to demand of the manufacturer was that the solids should be removed from the trade effluent; do you agree with that position?—Well, you see the moment you remove all the suspended solids you have gone the whole length of filtration; you have got everything; you have got pure water.

10619. But you may have a variety of things in solution?—Yes, but you have left pure water.

10620. But the water will not be pure?—You may have varying degrees of acidity.

10621. In the first place there is discoloration, degree of acidity, and alkalinity?—Yes, that is so.

10622. And then there are poisonous substances which may have been introduced, and which remain in solution in the effluent?—Yes.

10623. And which might in certain cases most materially interfere with the processes of purification of the sewage, that may be adopted later?—Yes.

10624. In the main, I mean the great difficulty with the trade effluent lies in the suspended solids?—The thing that ought to be removed before it is allowed to go into sewers, is the solids in suspension, and when you have met that then you have overcome the greatest objection to allowing the trade effluent to pass into sewers?—Yes. I go on a little further than that. I do not say that I would remove the whole of the solids, but it should be an arrangement, because you might have solids that would not interefere at all with your filration beds; that you could dig out, as you have in Bradford. You might have grease which would block your filtration beds at once.

10625. (*Colonel Harding.*) Would you withdraw the grease?—I think that would have to be an arrangement entirely with the authority. If the authority found that its filter beds would not work, they would have to say to the manufacturers: "This must be altered." Whatever was sent down. It was the same at Barking, in North London, here. After they had put down their filter works they had to hunt throughout the whole of North London to find where the solids came from. Eventually they got at it, and stopped them.

10626. Then your main thesis is that the regulations to be insisted on with the manufacturers should be an arrangement between the manufacturers and the local authority?—Well, I think it is the only system, after not considering the matter for one week or two weeks, not for a year or two years, but for a number of years, and after watching every system, and closely following what they have done in Manchester and what they have done in Leeds, I do not think it is possible to adopt any system which will be better, as far as removing the harassing anxieties of manufacturers who have not much money to fall back upon, and whose trade is not perhaps in a very good position, and who want to continue. I think that throwing it upon the urban district council, and upon the county boroughs, would relieve the manufacturers more than anything else, because at the present moment it is a very great scare with them. Colonel Harding, and the West Riding Rivers Board, think that the mill owners have been unjustifiably combative, probably in looking after their own interests, in the West Riding of Yorkshire. But I say, and I have told Dr. Wilson and Mr. Trevor Edwards so, over and over again, that there is no body of men, neither the rivers board, nor any one, more anxious than they are, if they will give us some system which can be carried out at an economical cost. After the report of the Manchester Corporation, where they found that both in connection with grease, and in connection with the ordinary sewage, natural precipitation would answer well as we would have put down works in several places, but Dr. Wilson said, "No, you will have to treat it chemically." He is just as wedded to that system as I am to a system of natural precipitation, time, and tanks to hold a quantity, because in the system that we proposed, that is, natural gravitation, we did not alter the water chemically—we did not alter the water in any way. With chemicals, of course, if you are going in theoretically you can work it absolutely perfectly, but when it comes to be that you have got a dozen mills within a very small area, and everyone introducing chemicals, I do not know that it would be worked correctly.

10627. Then you would leave the matter entirely in the hands of the manufacturers and the local authority?—I should, of course, with the Rivers Board, the Rivers Board would be the authority over the local authority, the same as they are now.

10628. Do you think the manufacturers should be required to pay a special rate or charge in the cases where they are allowed to connect with the sewers?—No.

10629. That should be borne by the public?—Yes.

10630. Then I think I might ask, are there any other points you would like to bring before the Commission?—No, I do not think there are very many, but I think there is possibly one matter, and that is, the difficulty in giving evidence here. Whatever one may say upon a thing which would apply generally, from the experience that we have had in the West Riding, we have found that it would not meet every case, that it is impossible to lay down a modus vivendi that would meet every case. We cannot do it, consequently whatever may be said is liable to be upset to a certain extent. For instance, in the Colne Valley, on the River Colne, no material change would follow the discharge of the trade waters into the public sewers, as it is intended having four outfall works within a length of five miles, so that the whole of the water would get back into the river on an average of about half-a-mile, so that in a case like that, that would not make any difference, but if you were to take Longwood and Batley, although there are very similar conditions prevailing, you cannot afford to abstract any of their water; it is so far removed from their outfall works, it is so far removed from their intercepting sewer that Huddersfield will be bound to make arrangements with Linthwaite and Golcar to have it treated before it runs through the centre of the borough. They could not afford to abstract it and take it down the whole length without treating it. There is nothing more I should like to say, except that there are instances where a manufacturer has no vacant land. We have two places like that; we have no vacant land at two of the works, and they are both fairly large works, John Crowther and Sons, Linthwaite, and Crowther, Bruce and Co., Marsden, we have no land at either, and that makes the problem much more difficult. It is desirable that some

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more intelligible basis should be found by which all manufacturers can be treated alike, because you find that out of 2,000 mills in the West Riding, nearly one-half of them are in the sewers; the exact figures were given by Dr. Wilson. In the Borough of Huddersfield a large proportion of the mills are connected to the sewers. The hardship is this—that whilst we have to contribute to the rates in that district, and have to treat our own effluent, our competitors get free. They have no more to pay either in rates or anything else If the law had to be remodelled, I should say everyone must either be out or everyone must be in; that they should have the option, at any rate. There might be cases where they might not be able to connect to the sewers, but in that case the local authority, so long as it takes the rates, ought to provide for it in some way; manufacturers would not find the least fault in our own district if they exempted them from paying the cost of treating domestic sewage, and said to them, "Deal with your own"; but they do feel that it is a very great hardship that they should have to deal with both. You might say, "Well, how would that be in connection with iron works and cotton mills where they do not foul any water?" I should say exactly the same; let the industries be free; I do not see why the whole taxation of the country should be put upon special industries; they will only stand it up to a point. They may go on too long. It is being tried now in a great many things, but it may be pushed too far. If you take the cotton industry—it has passed through a very severe crisis, and may again, but you cannot afford to put everything upon the industries.

10631. (*Colonel Harding.*) I should like to say, Mr. Crowther, that knowing you to represent a large number of manufacturers in your district, I have been exceedingly glad to find that you were coming before the Commission, and would have an opportunity of very fully laying your views before them. Now, I take it that you recognise the condition of the rivers in the manufacturing districts in Yorkshire has become so bad that some effort must be made?—I do indeed.

10632. You agree to that? Yes.

10633. And we are anxious to get from you some assistance as to how that should be done?—Yes.

10634. Well, I gather from what you said to the Commission that, speaking generally, you thought the remedy was to give the manufacturers the opportunity of connecting up with the sewers?—I think that would cause the least friction, and create the least trouble to the industries.

10635. And you would like that to be universally done. You say there is a hardship in some manufacturers in one district being allowed to connect with the sewers, and others in other districts not being so allowed?—Yes.

10636. And I gather the law should lay down some general laws compelling local authorities to take their effluent?—I think the law is strong enough if properly administered. One or two of the clauses in the 1876 Act were evidently put in for the purpose of whittling down what in the 1875 Act was absolutely clear. These clauses to-day are inoperative; you could not make them operative so far as benefiting the material that you keep out of the sewage works, because it could never be valuable for land. If these were struck out the local authority has no option; they must take it.

10637. You think the law should be so codified or simplified as to compel the authority to take the effluents of the traders of the district?—Yes, why not, when they pay?

10638. I am not questioning that; I say that is what you thought?—Yes.

10639. On the other hand, you thought that in regard to the conditions that might be laid down by an authority before it took the effluent and undertook to deal with the effluent, that these conditions ought to be left to mutual agreement between each separate local authority and the manufacturers?—I do.

10640. You did not think it was possible for legislation to lay down general lines?—I am sure it is not.

10641. That each case should be considered on its merits, and you would leave it to agreement between the local authority and the manufacturers to settle what conditions should be carried out before the effluent was received?—I would leave it to the local authority and the manufacturers.

10642. You would leave it to them?—Yes.

10643. But suppose they will not agree at all—which is the fact in a great many cases—they do not come to any agreement, and the matter drifts on indefinitely, what is going to be done then? They will not come to any agreement because they do not know what they will be compelled to do, and the manufacturer himself does not know what he can compel them to do.

10644. Here is the difficulty; you suggest to us that something must be done to remedy the condition of the rivers?—Yes.

10645. You say the best thing is to let the waters be received into the sewers, and it is best to leave the local authority and manufacturers to discuss the terms amongst themselves; but suppose, as is the fact in so many cases, as you know quite well, the local authority and the manufacturers do not come to terms, and the thing goes on indefinitely, being discussed in a vague sort of way—neither party being particularly keen to do anything at all, then what would you do?—Well, I should compel the local authority to accept its responsibilities and perform them. That is what I should do if I was on the Rivers Board, and I should compel the local authority not only to accept its responsibilities, but to carry them out.

10646. As you know, the Rivers Board has no power to compel the local authorities to receive effluents; it is a matter entirely to be considered?—I have no right to ask you a question, but you see we have fought several actions; it has cost us a great amount of money. Unless we had been an association we could not have spent money upon it. Take, for instance, Eastwood Bros., they were in the sewers; they were put there by the Urban District Council.

10647. I am afraid you are not answering the question. I was saying where the local authority and the manufacturers cannot agree, as is so often the case, what is then to be done?—The answer to my first question—make the law clear enough and strong enough.

10648. But the details are to be left between the manufacturers and the local authority?—Yes.

10649. You say that that cannot be laid down by the law, the conditions upon which the effluent can be received by the local authority are to be settled by mutual agreement?—You are asking now if there is an organised system of evasion.

10650. I did not speak of "an organised system of evasion"; these are your words, Mr. Crowther?—Well, these are my words.

10651. I did not suggest that?—Well, if they would not carry them out, how are you to have power to make them carry them out.

10652. Yes. If you found that they did not agree, and neither of them are particularly keen about agreeing there must be some power to get a manufacturer then, if he cannot agree with his local authority, to purify his effluent himself?—But, surely, the Rivers Board have authority now over the local authorities.

10653. But I am asking you?—Granted that the Rivers Board have power over the local authorities, your question is answered.

10654. The Rivers Board cannot compel the local authority to take in the trade effluent; that is a matter between the local authority and the trades?—But they ought to be able to compel an urban district authority to deal with its sewage, whether it is manufacturers' or whether it is domestic.

10655. All the Rivers Board can do is to compel the local authority to carry out the purification of such matters as have passed through its sewers; but it cannot compel them to receive it?—You would be perfectly warranted in asking for a clearer interpretation of the law.

10656. It is desirable, no doubt, but my own feeling is that it is not practicable to lay down by law regulations which would apply to all cases; they will have to be dealt with in accordance with their merits. But you told us just now—I am glad you reminded me—that you are connected with an association of mill-owners?—Yes.

10657. And that you have been defending certain cases at great cost, and so on?—Yes.

10658. But is the object of your association to assist mill-owners to find out the best way of purifying

effluents, or of carrying out suitable conditions before effluents are turned into the sewers?—The double object of the association, when it was formed and ever since its formation, has been trying to elicit from the Rivers Board, and the county authority before the Rivers Board existed, what would be satisfactory after the money was laid out; but the association declines, and it has declined, unless the Rivers Board will say to them If you spend a certain amount of money here, and use the best known system, that will be satisfactory to us. The millowners say: "No, it is no use our spending this money and doing it the same way as has been done in Lancashire, and other places, and when we have spent it, having to do it over again."

10659. Has this association engaged any expert or carried out any experiments with a view of finding out for itself what would be a reasonable and practical means of purifying the effluents in the district?—We have never lost a single opportunity, neither the opportunities which have been brought to us by Dr. Wilson nor the opportunities brought to us by people who had got a system which was approved by Dr. Wilson.

10660. But has the association as such carried out any experiments, or engaged any expert for the purpose?—Over and over again.

10661. Is there any report published of these experiments?—No, because these experiments have been in a very small way.

10662. Have they been carried out by the association?—They have been carried out by the association—yes.

10663. Then there is no report in existence?—No.

10664. At what expense have they been carried out by the association?—Oh, not very great expense. We have grease works in several places.

10665. Then the expense to which the association has been put has been rather in defending legal cases?—That is so.

10666. Not in carrying out experiments with a view to the solution of this great difficulty?—It is in watching every case that the Rivers Board said was satisfactory.

10667. That I am quite aware of?—I have reports here in every case.

10668. But in the direction of experiment nothing has been done by the association as such?—Yes, because in every case—in every one of these cases we have not only gone to see the works, but we have had some of the effluents to treat to see what would be the result.

10669. You made a statement to the chairman that the Rivers Board had kept themselves aloof, and had not conferred with the manufacturers, did you not?—Well, we have not had much assistance from the Rivers Board.

10670. But has not the Rivers Board been always perfectly ready to confer with manufacturers, and is it not perfectly ready now to confer with your association?—Yes; but their conferences simply amount to their stating "You have got this thing to do." Not how it should be done, nor will it be satisfactory or not satsfactory.

10671. It is the business of the manufacturer to find out how he can prevent pollution?—But surely the manufacturer has been allowed to establish these works, and it is a gross injustice and an injury to his industry.

10672. I am anxious not to discuss Rivers Board matters?—He has been allowed to grow up without this.

10673. All I am anxious to get as a member of the Commission, not as a member of the Rivers Board, is what suggestions can you give us for the improvement of the condition of these rivers. You have said the authorities ought to take the effluents into their sewers; but, as a fact, in a great many cases they will not do so. Well now, what do you suggest to us—that the law should make them do so?—Yes, certainly, I think the law is clear enough with one or two of those clauses omitted.

10674. But should the law make them do so without conditions?—No, not without conditions.

10675. Then these conditions would have to be considered by a local authority?—Those conditions if you attempt to embody them in an Act of Parliament will be found wanting.

10676. How are the rivers to be purified from the pollution of this trade refuse?—First of all the Rivers Board or the County Council whatever it may be—the Rivers Board now is the authority in the West Riding—by the Rivers Board having full powers over the local authority, and making each local authority responsible for its own district.

10677. The Rivers Board has no control over the local authority with regard to the reception of trade effluents?—They ought to have that power.

10678. They can compel the local authority to purify what passes through their sewers, but they cannot compel them to take into their sewers trade effluents?—They ought to have power to say to Urban District Councils the whole of the trade effluent you turn out ought to be turned out to our satisfaction.

10679. Do you not think great assistance might be given to this important matter by your association if it were to assist the local authorities and assist the Rivers Board in this way. Say, taking these effluents into the sewers is the best thing, we recognise that they cannot be taken in full of grease and full of solids; we think that some previous treatment is required by the manufacturers and by your association making experiments to find out what is the best thing which the manufacturers can do within reasonable limits of cost so as to induce the authority to receive partly-purified effluent; could you not render great services in that way?—I believe we could; I believe we could be of great mutual assistance to one another.

10680. Would not the money be better spent than by obstructing the work of the Rivers Board?—Very much better spent, but we have never got that from the Rivers Board; we have never got the Rivers Board to approach us in that spirit.

10681. I am a rather important member of the Rivers Board, chairman of the Committee, and I have over and over again expressed my readiness to discuss these matters with you?—We have in the correspondence over and over again offered the Rivers Board to put down plant, series of plants. Dr. Wilson asked over and over again, and we said we will put down whatever you recommend.

10682. (*Chairman.*) Experimental plant?—Experimental plant; we would have put it down in the most favourable or the most unfavourable positions; we would have done anything.

10683. (*Colonel Harding.*) Then do I understand your association is ready to put down experimental plant?—Yes, that is so.

10684. For the purpose of purifying trade effluents so as to permit them being received into sewers?—If they were going to be received into the sewers.

10685. That is quite admirable. There is no doubt your association might render very great services indeed to the whole district if they carried out work of that kind. I confess it is perfectly new to me?—We are perfectly willing.

10686. If you are prepared to do this you must believe, and I am delighted to hear that you do believe, in the possibility of the purification of these effluents?—No, we do not believe in it, but we want an assurance from Dr. Wilson that it would satisfy the Rivers Board, and that is the only thing we have been waiting for.

10687. (*Chairman.*) You want to prove you cannot do it?—We want to prove that what is in existence is not doing it

10688. But the experimental plant, I mean, as to the possible methods of producing change in the effluent so that it may be received in the sewer. I understood that was your answer to Colonel Harding that you had an experimental plant with a view of investigating how to treat the trade refuse, so as to bring it in such condition that the sewer authorities will readily receive it?—Yes.

10689. But now I understand those experiments chiefly tended to prove that that cannot be done?—The only thing we can possibly go by are the best places that we have been recommended to look at by Dr. Wilson and his inspectors. That is all that we can do.

10690. (*Colonel Harding.*) Have you investigated that?—We have been to every one of them.

10691. It will be interesting to the Commission to know that; what particular trade are you referring to—the woollen trade, and the effluents consisting largely of soap-suds and grease?—Well, I am referring to the places at which it has arisen.

10692. In such places as that, where?—Did Dr. Wilson refer you to the places where the processes have been carried out that he would consider satisfactory;

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where was it?—Yes, there was Kelsall and Kemps, Limited.

10693. Where is their place?—At Norden, Rochdale.

10694. And you were referred to them to see what he considered fairly satisfactory plant?—Yes.

10695. For extracting the grease?—Everything.

10696. And the solids from the effluent?—Yes.

10697. Well, and what did you see there?—Well, we found that it did not justify at all the statement which had been made.

10698. Did it improve the effluent?—Oh, yes.

10699. (*Chairman.*) But it could not be done?—Do not for one moment, Colonel Harding, suggest that in any remarks I am making that what has been done does not improve the effluent; I never intended to convey that information.

10700. (*Colonel Harding.*) Well, I rather gathered that?—Oh, dear, no.

10701. (*Chairman.*) There was an element that went throughout, namely, what the manufacturer can afford to do?—That is so.

10702. (*Colonel Harding.*) Then you agree that in those places to which you were referred, a great improvement was brought about in the effluent?—Yes.

10703. Were the people ruined who did it?—Were they ruined; no, they were not ruined.

10704. Was it practicable?—It is practicable, but at a cost. It is very difficult indeed for everyone to carry it out. I will give you one short case. I brought a case with me, where the judge himself said: "Well, if this man goes any further his trade is not worth following." I will give you the case.

10705. Let us cling to this particular specific case; here are people carrying out a process which brings about great improvement in the effluent?—Oh, it is an improvement, yes.

10706. Well, they are carrying it out; they are continuing it?—Yes, but the cost is very great, and this is a case where Dr. Wilson said it was profitable.

10707. But it is a cost which that firm is prepared to incur?—They would not have incurred it if they had not been bound to it.

10708. They have been forced to it, but they are doing it, and they are not ruined by it?—They are not ruined by it, but they have so much less money.

10709. You do not suggest that purification of effluent must only be carried out where it can be done at a profit?—I do not.

10710. It must be done at a cost?—And I do not suggest that the purification of effluent should be carried out at such a cost as to spoil the industry.

10711. It must not be carried out at a cost ruinous to the industry, I grant you. No one wants that to be done?—No, but still I know it has been carried out, and it has injuriously affected small people.

10712. But you seem to be actuated by a belief that really nothing can be done, practically, for the improvement of effluents?—On the contrary, I think a great deal can be done.

10713. Well, tell us what can be done?—Well, for instance, all the soap and all the grease has been taken out for years—not all of it, but to a very great extent.

10714. Well, they take out as much grease as it pays them to take out; is not that the condition of things?—Probably, in some cases, but we do it at the Globe Worsted Company's Works, Slaithwaite, now without any regard to whether it pays or not.

10715. Well, that is the proper way to look at it, is it not; that in the public interest this plant has got to be put down whether it pays or not—and the probability is that it will not pay?—Yes.

10716. It is very satisfactory if it will pay; but even if it does not pay it has got to be put down, provided the cost is not absolutely injurious to the industry?—Yes.

10717. Then you agree the grease ought to be withdrawn and the solids ought to be withdrawn, do you?—Yes, I agree that everything ought to be done that can be done; but not for the manufacturer to be at the cost of taking out all the grease and everything else, and have to pay for the whole of that himself, and have to pay his rate in addition. Surely, no men, no fair-minded men in the world would suggest that a thing like that was equitable. Give us either the one or the other. Take us away from the domestic rate, and say, "Treat your own, and do everything."

10718. And you have no practical suggestion to make to us then, in regard to how to treat effluents in your business; you have seen these referred to by Dr. Wilson, you have found them bringing about a good result, but you are not prepared to incur that cost?—I do not say we are not prepared to incur any cost if it would be satisfactory to you. I think I could get the millowners in a body to be prepared to give you a lump sum down for you to do it by yourselves, and leave you the handsome profits.

10719. (*Professor Ramsay.*) What you object to is the uncertainty of it?—Yes, that is so. Taking the most meagre estimate that we can form, it means that a million and a-half of money will have to be spent upon the meagrest outfall provisions for these firms. An industry cannot go on bearing this sort of thing, and having it repeated over and over again; they cannot do that without limit.

10720. (*Colonel Harding.*) Is your Association prepared to carry out some experiments in the interests of manufacturers who are members of the Association for the purpose of finding the best way of meeting this difficulty?—If the Rivers Board will approve of it, certainly.

10721. The Rivers Board will be only too delighted?—If we knew we had the assurance of the Rivers Board that we were on right lines we would do anything you wanted us to do, but the Rivers Board decline to give us any assurance whatever; and not only so, but they have compelled us to lay out a lot of money, and they say, "Well, you must start over again right away."

10722. The Rivers Board are prepared to give you every assistance in their power, but it is no part of their business to tell you?—Is it part of our business? It would ruin all our businesses to lay out a large sum of money, and then have the works condemned by the Rivers Board. I could give you case after case where a large amount of money has been paid in the West Riding of Yorkshire, and where the manufacturers have been doing the best they can; and then the Rivers Board have condemned the works.

10723. Your Association, in the interests of this Commission, can do great service?—We will do everything we can if we can get an assurance that there is some finality about it.

10723.* You cannot do that without carrying out your experiments; show what you can do, then you can come to us and say, "We can do this much within reasonable limits of cost. Will that satisfy you? If not, show us something."

10724. (*Dr. Burn Russell.*) Finality seems to be an extraordinary condition to attach to an experiment?—Well, I must apologise for using that word.

10725. (*Chairman.*) Probably what you meant was the very best known means available—it is defined by the Rivers Board. You make an experiment, you state the result, and you want the Rivers Board to accept those as your results?—I only want to point out to you exactly what exists, and what has been proved to be a very serious matter, indeed in more than one instance, or more than two instances, and that is, that you are called upon to experiment, and to spend a large sum of money, and when you have done it, what you have spent is absolutely ineffective.

10726. (*Dr. Burn Russell.*) That must have been a definite prescription of some form of experiment?—The very best known means available—it is defined by the Act—of treating your trade effluent, because that is all the Act says. It says all you have got to do is to carry out the best known means, but the Rivers Board are not satisfied with that.

10727. (*Colonel Harding.*) The Rivers Boards are keenly anxious to see this work done?—I am as anxious as you are.

10728. I was going to say, as a member of the Rivers Board, we shall be very anxious to meet your Association if we can be of any service in helping you all we can, putting at your disposal all our information, as Dr. Wilson has done in this particular case you went to see, which is so far satisfactory, but in your opinion too costly, and to assist you in making experiments to find out some simpler way?—Dr. Wilson said, when he came

to see me about the Commission, "Would you like to see Colonel Harding and some members of the Rivers Board at a meeting?" I said, "Yes." He said, "Will you be prepared with something definite?" What can we do definitely?

10729. Well, you can do this—you can get advice. Why can you not engage an expert, get advice, have experiments tried at some one place, some one manufactory, and then you will forward the solution of this difficulty?—But I have been through all the largest works that have been put down, both at Barking, and all over, and I see exactly the result. What can you do?

10730. You mean that the result is bad?—The result is not so satisfactory that it would pass the Rivers Board.

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10731. If you do not believe the thing can be done, I am afraid we will not accomplish much?—Well, if I were to tell you what I know here, in connection with what is reported, and what has been reported before your Commission, over and over again, as being satisfactory, you could not realise it. I have been there myself and seen it, and been over it, and it is not that we do not want to carry it out, but we are willing to carry it out if we knew that when we had spent our money we had done with it.

Mr. George Crowther Hirst, called; and Examined.

Mr. G. C. Hirst.

10732. (*Colonel Harding.*) You are, I think, Mr. George Crowther Hirst, of Messrs. C. and J. Hirst and Sons, Limited, Sunnybank Mills, Longwood, Huddersfield?—Yes, sir.

10733. And your firm is a manufacturing firm connected with what branch of business?—Woollen manufacturers.

10734. And I see you produce some 400,000 or 500,000 gallons of trade effluent a week?—Yes.

10735. And you discharge that into the stream?—Yes.

10736. What is the stream which passes your works?—It is called Longwood Brook.

10737. Is it at the present moment in a very foul condition?—Yes, very bad.

10738. I suppose you agree that the condition of the streams in your district and Yorkshire generally is very bad indeed, and that something is required to be done to improve them?—Yes, especially the smaller streams. When you get a fairly large river it is not so offensive.

10739. All the tributaries of the Aire and the Calder?—Yes; this stream runs into the Colne.

10740. In your particular case, is the sanitary authority willing to take the trade effluent?—We are under two district authorities—that is, the stream is the dividing line, and part of the works is in one district and part in the other, and in both cases, just where the foul water is made, the room in which it is made is over the brook, in each case, so we can be either in one district or the other, at our option. Now, one authority has made a specially large sewer just passing our works some four or five years ago, and when they made it they took our sewage water. I may say that the water was going across a road into the brook on the other side, and they took our drain and put it into the sewer.

10741. A drain carrying your trade effluent?—Yes, and at the same time sent us an agreement which they wished us to enter into; but, owing to the difficulty we knew we should have to meet with by manufacturers lower down the stream, if we took the water out and the conditions they laid down that it was to be free from detrimental water, we refused to put it in—that is, we preferred to turn it into the stream, as we were already doing.

10742. Why did you do that? Was that because of the expense of the appliances required to carry out the conditions of the local authority?—They would have accepted it for the present as it is, but we did not know how soon they would compel us to do some kind of purification.

10743. And were you unwilling to do any kind of purification?—Well, the reason, as I said, is that we preferred to do as we were already doing, to put it into the river in its present state.

10744. Naturally, because then you would not have any money to spend at all?—No.

10745. But what were the conditions, can you tell us, that this local authority laid down?—I am afraid I cannot; but the large proportion of the manufacturers in Huddersfield accepted this agreement, and put their polluted water straight into the sewer.

10746. After certain precipitation?—No.

10747. Without any preliminary treatment at all?—As it is, yes.

10748. But in your case they asked for a preliminary treatment?—No, they asked us to sign an agreement that we would put nothing of a deleterious nature into the sewer.

10749. As a matter of fact you were turning out grease, were you not?—Yes.

10750. And signing that agreement was an equivalent to removing grease before you put the effluent into the sewer, was not that so?—No, it was more, that we must not put in anything that would hurt the sewer; but we thought they might construe it to make it very onerous, and practically make us purify it before we put it in.

10751. Then it was the uncertain character of the conditions which deterred you from agreeing to that?—That was one question; but the first point I mentioned was that if we took our water out of the stream that we were at present turning it into, the manufacturers below would be at a great disadvantage, and they allow us a privilege at present in fouling it, and using the water which perhaps strictly in law they could prevent, and we did not want to create any disturbance amongst our neighbours, which would be the case if we stopped it altogether.

10752. The withdrawal of that volume of effluent from the stream would be an evil?—Yes, it would.

10753. You are a manufacturer, and we have asked you to come before us, and assist the Commission with any suggestions that you may have to make. We suppose you are quite alive to the fact that the condition of these streams in the manufacturing districts has become so bad that something must be done to improve them?—Yes.

10754. Now, as a manufacturer, what suggestions can you make to us; do you think trade effluents ought to be taken into sewers, as a rule, or do you suggest, as I think you rather do, that it is not practicable for them to be taken into sewers, because you cannot afford to withdraw from the stream so large a volume?—Yes.

10755. But suppose, where it is possible, without interfering with the people using the stream below, to turn an effluent into a sewer, do you consider that that is the simplest issue for the manufacturer?—Yes.

10756. And do you think that manufacturers generally would be willing to carry out any reasonable conditions that must be laid down by the local authority?—Well, to be candid, I feel sure they would not, unless they were compelled to.

10757. You do not think they would go so far as to carry out any reasonable conditions of the local authority, because clearly if they did not put the effluent into the sewer, and had to turn it into a stream, it is almost certain that they would have to carry out a higher degree of purification than if the effluent went into the sewer, is it not?—Yes, but at present, although I have no doubt every manufacturer has been written to by the Rivers Board, asking them to treat their trade effluents, very few have done it, even to any extent. Now you know I say that we treat to some extent, but a very considerable number of manufacturers do not do anything.

10758. Let us probe that a little bit. I see you say that a part of your effluent is treated to some extent?—Yes.

10759. Well, just tell us what you do to it?—We run it into what are called seak tanks, that is, the greasy portion. We have two distinct characters of effluent, a greasy effluent, which is caused by washing the oil, and also the soap that is put on out of the pieces, the dirt consists there almost entirely of grease. Then we have another kind of effluent, which is from dyeing, and that is chiefly colouring matter, and is really not very detrimental from a health point of view.

10760. Are the two mixed together?—No.

10761. They flow separately?—Yes, they are produced in different buildings.

10762. Then the greasy water you say passes into a seak tank?—We take the greasiest—the dirty water

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only does not pay to treat, because it has not so much grease in it.

10763. May I take it then that the operation of the seak tank treatment is not the purification of the effluent but the obtaining of grease for the purpose of profit?—That is so.

10764. Therefore you cannot claim that that is a process of purification?—It is not done in order to comply with the Pollution of Rivers Acts. The plant was put down some years ago, and is profitable.

10765. But not for the purposes of purification, but obtaining grease for yourselves?—Yes.

10766. Then do you do anything at your own works for the purpose of purification?—No, we do not, because the river is in such a state when it reaches us that we do not consider we are called upon to do anything until the people higher up the valley have done something.

10767. Is it not by each person doing what he can that the river can be improved?—Quite so, and we are quite willing to do a reasonable share; and before this inquiry was brought before us we were contemplating making preparations to do it.

10768. Now what the Commission wants to know from you as a manufacturer, and conscious of the difficulties that lie in the way, is what suggestions can you make to us in regard to the purification of the rivers from this source of pollution from trade effluents?—Well, I think if the Rivers Board would treat manufacturers reasonably, that is, would only require them to do a moderate amount of purification, that the manufacturers would do it.

10769. And you think then that the solution of the question is in manufacturers carrying out the reasonable requirements of the Rivers Board and other inspecting authorities?—Yes.

10769*. And from your own experience, and knowledge of your neighbours, do you think they are willing to do something towards the purification of their effluents?—I do not think they are particularly willing.

10770. Is your firm willing?—It is to a certain extent.

10771. You have only these seak tanks, have you?—That is all.

10772. Which are not primarily for the purpose of purification, but for the purpose of profit?—Yes. That is so. The position is this: at the head of the stream there are large manufacturers, and one of the firm is the chairman of the Huddersfield Sanitary Department, and he is also the representative of the Rivers Board. He does absolutely nothing except seak tanks; but we are given to understand that he is, and he assures me that he does intend to at once purify the river, and make it clean past his works, and immediately he does that we shall be prepared to do the same.

10773. (*Professor Ramsay.*) Is he furthest up the river?—He is at the head of the river, but Dr. Wilson wished me to bring a plan showing the condition at the head of this river, by which you will see that there are four mills on this stream, each of which takes out water practically at the head of the stream. When the stream got dirty, no one could take water out of it, it was so foul to begin with. And, therefore, these manufacturers who buy water from the Corporation, or get it from springs, are at liberty to turn it into the sewers if they wish, without interfering with the riparian rights of the people down below. But all these mills have the clean water from the head of the stream, and if they all turned theirs into the sewer the mills below would be put to a very considerable expense, and practically at certain times of the year would not be able to run their engines owing to the heat of the water in the small stream that would be left.

10774. (*Chairman.*) Then what you suggest to us is that there are evidently cases where it is not practicable to turn an effluent into the sewer, even if the authority were willing to receive it, because of riparian rights?—Yes, that is so.

10775. In that case the only thing to be done is that some purification should be done by the manufacturers?—Certainly.

10776. (*Professor Ramsay.*) Does the water that you use for dyeing come from the stream above you, or do you get it from the town?—We take a certain portion out of the stream itself, and put it back, but it all comes out of the stream. We buy very little from the town, because at the head of the stream there is a large reservoir about 70 million gallons, which was made by the Corporation of Huddersfield in lieu of certain waterworks they made higher up. The flow of water from this reservoir is regulated by these four mills, and only sufficient water is turned out to run the engines of the largest mill, which is at the head of the valley. Therefore the people below get only the water that these people have used for their manufacturing processes and running their engine.

10777. But that is clean water, I presume?—That is all clean water at that point, and then they also get what comes down a pipe, about a 4in. pipe, which each of these mills on the way taps.

10778. Is that water that is used for dyeing?—Yes.

10779. Then do you turn out a coloured liquor into the stream with your spent dyes?—Yes.

10780. That is turned into the stream?—Yes, so far as I know there are practically no purification works in the district of Huddersfield which contains an enormous number of mills.

10781. (*Chairman.*) Are you a member of the Huddersfield Millowners' Association?—We are, but that practically makes no difference, because it is very doubtful whether we ought to be or not.

10782. Do you mean that you have moral qualms about belonging to that Association?—Well, I do not know

10783. I do not want to pursue that more if you have any hesitation in answering?—I do not exactly know what you mean.

10784. Well, is the object of the Association, so far as your experience of it goes, to further the purification of the rivers?—I have never seen anything to make me think that it is; as far as I know it is to fight the Rivers Board, so far as any business that I have ever heard of them doing.

10785. You have not found that their object was to promote the purification of the rivers?—No, indeed. Since this Act came into force a few manufacturers met together to consider the question, and formed themselves into a small local association down one valley, then in another valley a similar state of affairs takes place; then they amalgamate into a large association over the West Riding generally.

10786. It is not worth while pursuing that further?—I was only saying how we got into it.

10787. You are satisfied something ought to be done to purify these rivers?—Something ought to be done.

10788. And many firms will have to be called upon to do something for the purification of their several effluents?—I think they ought to be.

10789. In your particular branch of the trade, I suppose the effluent does not come out in particular rushes. It is not only emptying of large vats, or in that way that the effluent comes into the stream?—Yes, it does both ways, chiefly in rushes.

10790. Do you not think it would be an advantage that manufacturers should be called upon to make the effluents come by a steady flow spread over the 24 hours into the stream?—I do not see how he could manage that.

10791. It might be managed by having simply an intermediate tank?—Yes.

10792. And the vats are emptied suddenly, if it is necessary for trade purposes that it should be so, into this intermediate tank, then into a pipe of a given size, so that the flow is continuous for 24 hours. Would that be an advantage?—I do not think there would be any advantage to anybody doing it in that way.

10793. Except that the pollution would be less foul if it came in a minute trickle than if it came in big rushes all at once?—No. I do not see it; I do not see any advantage in that system.

10794. You do not think that, so far as your particular trade is concerned, there would be any advantage in having intermediate tanks to secure a regular flow?—I do not see where the advantage would arise.

10795. I understood your experience was that manufacturers were not particularly ready to adopt means for the removal even of suspended solids or grease?—Well, seeing that, so far as I know, there is no manufacturer in the Huddersfield district has yet done so, that is a sufficient answer.

10796. They would do it if they were made to?—They would have to.

10797. You do not think it would ruin the manufac-

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turers to carry out works of that sort. Would it?—I think not if it were done in a reasonable way—manufacturers are rather afraid. They say, "To what extent will they require us to purify it, and what system can we adopt?" and therefore, in the meantime, not being compelled, they do nothing.

10798. Where it is possible, without interfering with the rights of riparian owners, to turn into a sewer, where the authority is willing to receive it, you think that is the simplest issue of that difficulty?—Simplest for the manufacturers.

10799. Simplest for the manufacturers?—Undoubtedly.

10800. You think that it would be useful to have some tribunal to whom appeal could be made when the local authority and the manufacturers disagree as to these measures?—No, I do not see that you could—at least I have not been able to.

10801. You think it is best left to the local people themselves?—Yes; they will have to fight it out as best they can. I do not see that you can make any tribunal.

10802. It has been suggested that where a local authority takes trade effluent that it would not be interfering to charge the manufacturer a special rate. Do you think that would be a right thing to do?—I think so.

10803. That it would be fair and just to place the burden of purifying his effluent upon the manufacturer himself, even if it be done by the local authority?—I think so. You see that even in a large mill, so far as I can make out, their effluents would cost more in purification than the rates they at present pay; but take a business which is partly dyeing and finishing or scouring—the cost of treating their effluents would be much larger than the present rates, according to any statistics which we have been able to get.

10804. But, where practicable, you think the local authority can deal more economically with a variety of effluents mixed together than can the individual manufacturers dealing each one with his own?—That is a question I have not any information on; I have not had to deal with mixed sewage.

10805. Is there any other point you want to lay before the Commission on this matter, or any observations you would like to make to us on the general question of the purification of these streams from this source of pollution?—I am afraid I am not in a position to give you any information of that character. People who have had experience of purification works know more about the question than I do. I have seen a few, but I do not say that I am qualified to give you any opinions as to the results.

10806. (*Professor Ramsay.*) Do you turn into the stream a dark-coloured effluent to be used by dyeing works below?—They do not use it out of the stream for dyeing, except to a very small extent for black dye.

10807. There are no works below you which purify your effluent, after it forms part of the stream, in order to use it for dyeing?—No.

(*Chairman.*) We thank you for coming before us; we are glad to know that manufacturers, without ruin, will be able to carry on works if they are made to.

THIRTY-SEVENTH DAY.

Wednesday, 7th May, 1902.

PRESENT:

The Right Hon. The Earl of IDDESLEIGH (*Chairman*)

Sir MICHAEL FOSTER, K.C.B., M.P., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Mr. W. H. POWER, F.R.S.
Professor WILLIAM RAMSAY, F.R.S.
Colonel HARDING.
Dr. JAMES BURN RUSSELL.

Mr. F. J. WILLIS, *Secretary*.

Mr. JAMES BRUCE, called in; and Examined.

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10808. (*Chairman.*) I think you are the general manager to Mr. Harold Nickols, tanner and currier, Joppa, Meanwood, Kirkstall, and Beeston Tanneries, and Burley Mills Currying Works, Leeds?—Yes.

10809. For the purposes of your business do you take any water out of the stream?—At Meanwood.

10810. And, therefore, you have to return it into that stream?—That is so.

10811. But in the other places where you have works you do not take water out of the stream?—No.

10812. And there you are not bound to return it into the stream?—No.

10813. It is the case, is it not, that at Joppa, Meanwood, Kirkstall, and Beeston Tanneries, the effluent is treated before it goes into the sewers?—Yes.

10814. (*Sir Michael Foster.*) What is the general character of the treatment at those places?—The effluent is carried through settling tanks, where the solid matter is mostly caught, and from there it flows into the sewers, and is regulated by valves so as to maintain an equable flow.

10815. Does it contain much matter in solution?—Not after it has passed through the settling tanks.

10816. (*Colonel Harding.*) I think you must have misunderstood the question of Sir Michael Foster; in solution, Sir Michael said.

10817. (*Sir Michael Foster.*) In solution?—In solution. Well, of course, I am not a chemist, and I, perhaps, can hardly answer that quite correctly. All that I can say is that it seems to satisfy the sanitary authorities of Leeds; we have had no trouble with them.

10818. (*Colonel Harding.*) As a liquid to go into the sewer?—Yes.

10819. But it is a highly-coloured liquid, and a very impure liquid?—It is highly-coloured, of course, at all our places.

10820. (*Chairman.*) Then at Meanwood the tannery water is taken from the stream and there treated through settling tanks and earth tanks before going into the stream again?—Yes.

10821. What is an earth tank?—It is simply an excavation in a field; drain pipes have been laid down and covered with stones to protect them from being silted up with the earth itself. Then the soil has been placed back again, and a mixture of breeze and ashes laid with it.

10822. Then, in fact, it is a filter?—Practically a filter, yes.

10823. (*Sir Michael Foster.*) At Burley Mills you have works?—They are on a very small scale, indeed; we have a very small effluent from Burley Mills.

10824. Does that go into a sewer?—No, that goes into the river, but we have such a trifling effluent that it passes through a small settling tank before going into the river.

10825. (*Chairman.*) The only place at which you do any filtration, then, is at Meanwood?—Yes.

10826. Do you consider that the positions and the rights of the manufacturers and the local authorities

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under the existing law are clearly defined?—I have found that a somewhat difficult question to answer, for it seems to me to be more for the lawyer to answer, but, so far as we are concerned inthe Leeds district, it pears to me that there is no difficulty in the matter.

10827. Then, generally speaking, you are satisfied with the present position of the law?—So far as we are concerned, we are.

10828. (*Sir Michael Foster.*) You have met with no difficulties at all?—None, whatever.

10829. (*Chairman.*) As I understand you, you have provided for a steady and regular flow of your effluent? —That is so, before entering the sewers; it is not so in connection with Meanwood effluent, which is turned again into the stream. The flow simply continues during the day and stops at night.

10830. That is why you filter it?—Yes.

10831. (*Sir Michael Foster.*) But it is regular, so far? —It is fairly regular during the day.

10832. (*Major-General Carey.*) How do you regulate it?—We have no means of regulating it, only our output is a fairly regular one, and, therefore, the outflow from the earth tanks is equally regular.

10833. It is accidental that it is so?—We have no control by way of filters or anything of that sort over it. It is just the natural flow as we make the effluent during the day.

10834. (*Colonel Harding.*) In order to regulate the flow you have recently introduced storage tanks?—That is so.

10835. Was that at the desire of the Corporation of Leeds?—Yes, we placed ourselves in their hands, and agreed to do anything they wished us to do.

10836. And you put also an inspection chamber, did you not?—Yes.

10837. (*Chairman.*) From your own knowledge, would you be prepared to think that manufacturers would be willing to adopt means for the removing of suspended solids or of grease from the trade refuse before it was allowed to discharge into the sewers?—Well, I consider that now manufacturers are far more amenable to reason in this matter than they were. I believe it has been found that it does not pay to kick against the pricks of the law in the matter, and that, so far as my own knowledge of many manufacturers in our district goes, they show a far greater disposition to fall into line in this matter.

10838. (*Sir Michael Foster.*) By reasonable, you mean such conditions as would not interfere too much with their profit?—Exactly.

10839. (*Chairman.*) When a local authority refuses to allow trade refuse to go into the sewers, do you think there should be some tribunal other than the Law Courts to whom an appeal could be made?—I certainly think so.

10840. Have you any suggestion to make as to what sort of tribunal that should be?—Well, we have had some experience ourselves of a court of law, and I am of opinion that that is not the best tribunal for a matter of this sort, and, in thinking this matter over, and taking into consideration the way in which we have been treated by the West Riding Rivers Board since we came into line with their views of the matter, I am inclined to think that a rivers board, conducted, say, on the same lines as the West Riding Rivers Board, would be a very sensible tribunal.

10841. You speak well of the Rivers Board?—I have found the Rivers Board quite fair and reasonable, and I do not think that any manufacturers, if treated as we have been treated within the last two or three years, would have any reason to complain.

10842. Do you think that manufacturers ought to be required to pay a special rate or charge when they are allowed to connect with the sewers?—Where some expense has been incurred, and is being incurred for removing, say, the solid matter from the effluent, I scarcely think it is fair to expect them to pay any additional rates over and above the ordinary local rates, but where no treatment at all is carried on I certainly think it is only right and fair that an extra payment should be demanded.

10843. Could you tell us at all what the difficulties are that the manufacturer usually meets with in dealing with local authorities, and what reasons would generally be advanced by the local authorities for refusing to allow trade refuse to go into the sewers?—Well, so far as Leeds is concerned, we have found the authorities very reasonable in their requirements, and we ourselves have not had any difficulty placed in our way, so long as we conform to certain reasonable stipulations, such as the maintenances of a regular flow: we have had no difficulty with them.

10844. (*Sir Michael Foster.*) But you said during the last two or three years?—Yes.

10845. Do I understand you had some difficulties before?—Well, it is only during the last two or three years that we have absolutely completed all our arrangements at all our works, and that is my reason for saying during the last two or three years.

10846. But you had some difficulties previous to that? —Well, prior to that, like a good many other manufacturers, we certainly did not like to pay money down, incur a lot of expense, when, at the end of that expense, we were not sure of satisfying the authorities. That was our position then; the authorities did not seem to know exactly what they required, and, owing to that uncertainty, we felt disinclined to incur any great expense.

10847. That really was your difficulty?—That was our difficulty.

10848. With the local authority?—That is so.

10849. Then, in your opinion, the local authorities did not know their own minds?—To a large extent, that was so.

10850. (*Major-General Carey.*) What requirements are made now by the local authority?—The requirements now are chiefly that you shall get your effluent as reasonably clean as you possibly can without ——

10851. (*Sir Michael Foster.*) By clean you mean free from suspended solids?—Free from suspended solids, and the maintenance of a regular flow. I think those are the two great conditions in connection with the local authorities.

10852. (*Major-General Carey.*) And is your effluent inspected by the Leeds authorities?—Periodically.

10853. Before it enters the sewer?—Periodically, it is inspected by their inspectors. We have catch buckets for them to come and inspect themselves at any time, and the chamber is under their control. It is locked, and the key kept by them, and the controlling valve is also under the lock and key of their inspector. But we have found them very reasonable. For instance, not very long since, we found that the check valve was scarcely open wide enough, and the consequence was that we were seriously flooded one time, and, upon calling the inspector's attention to it, he admitted that it was perhaps hardly open sufficiently, and he just opened the valve a little wider, and since then we have had no trouble.

10854. Is that expression "reasonably clean" defined in any way; how do you know when it is reasonably clean?—Well, I use the words advisedly, because there are so many different kinds of manufacturers' effluent, and, I think at first from our own experience, the local authorities, as well as the Rivers Board, laid down a law which should apply to every class of manufacturer, and I think that this was found not to work very equitably. It was found impossible, I believe, to so frame a standard that should apply to every kind of effluent, and since then they have according to the kind of effluent, and according to the special circumstances, met the manufacturer, I think, in a very fair and reasonable spirit, and they are willing to take effluent now which is judged according to circumstances and according to the class of effluent which that particular trade will make.

10855. Do you know when you have passed the effluent down to the sewers that it is reasonably clean, or that it will satisfy the requirements?—Yes, of course we can see, and we do periodically take glasses and make sample tests to see how the effluent is for the time being.

10856. (*Chairman.*) What would be the effect on the flow of the water in streams if the trade refuse were diverted from them into the public sewers, and would you consider that any alteration of the law is desirable so as to permit the abstraction of dirty water from the streams?—Well, speaking for, say, the Meanwood beck in particular and the Leeds district generally, I should say that there would be a considerable curtailment of the water in the streams if it were not returned, but so far as we know, I believe that it would be almost impossible. The water rights of the Aire and Calder Navigation, I believe, claim the whole of the watershed of our district, and when the local authorities and the West Riding Rivers Board took

this matter up very strongly a few years ago about treating the effluent, we had a notice very promptly from the Aire and Calder Navigation, threatening us with all sorts of divers threats of law proceedings if we took any water from the stream and did not return it.

10857. Then you would consider that the water must be returned to the stream?—I fail to see how you could possibly do otherwise.

10858. (*Sir Michael Foster.*) What occurs to the water when you take it from the Meanwood beck; is it pretty pure?—It is fairly clean water, yes; it is fairly clean water.

10859. (*Colonel Harding.*) Your experience in this matter is limited to the trade effluent from tanneries?—Exactly.

10860. And tanning is one of the important trades of your city?—Yes.

10861. And at that Meanwood beck there is quite a number of tanneries?—Yes.

10862. Of course, where a tanner can get permission to turn his trade effluent into a sewer the thing is comparatively easy?—Yes.

10863. You then have simply to take out solids, and although the effluent which would pour into the sewer is really still very foul, it is an effluent somewhat of the same character as domestic sewage, which can be dealt with wholesale by the local authority?—Yes.

10864. But your evidence has been interesting as showing that even in a place where the local authority is perfectly willing, under reasonable conditions, to receive effluent into its sewers, manufacturers cannot always turn it into the sewers because of the rights of navigations and riparian owners?—Yes.

10865. In your case it would be rather interesting to have known exactly the condition of purification to which you brought your effluent at the Meanwood works after passing it through the settling tanks, and through the filters. You have not brought with you any sample, have you?—I have no sample with me.

10866. I have not had the opportunity of seeing your works lately; can you give us any idea of the condition of that effluent when you turn it into the stream? Now, for instance, is it fairly clear from solids?—It is very clear indeed from solids.

10867. Then to what extent is it discoloured?—It varies just a little; but taking it on the average it is very light, what you might term, say, claret watered down with about three parts of water and one part of claret; that would give you about the average colour of our effluent.

10868. You have not had any analyses made, I feel sure, to ascertain the amount of dissolved impurity?—Not ourselves.

10869. (*Sir Michael Foster.*) Have any been made at places?—Yes, by Dr. Wilson.

10870. (*Colonel Harding.*) By the Rivers Board?—The Rivers Board, I believe, make periodical analyses.

10871. You are quite conscious that it is very far from being what it ought to be, being turned into a stream?—That is so.

10872. But you have found the Rivers Board so far reasonable that now that you have purified it to that extent they are not pressing you to do anything more at present?—Not at present. Dr. Wilson has brought it to my mind that he would like another filter bed put down; but we are in this position: our lease has two years to run, and although we have made overtures for a new lease we have not been successful so far, and pending what may be done with respect to a new lease, I have advised Dr. Wilson that in the event of a new lease being made we will put another filter bed down at once.

10873. Then are you now treating the whole of the effluent through the filters?—The whole of the effluent goes through the filter beds.

10874. Are you at liberty to tell the Commission at what cost you accomplish that result?—Yes. I have the particulars with me. With respect to Meanwood, the total cost of the settling tanks and filter beds is about £560, and the annual labour cost is about £150.

10875. Yours is a considerable tannery, is it not?—Yes

10876. What is the volume of your flow?—It is about 20,000 gallons per day on the average.

10877. Then, I suppose I may take it you are of opinion from your experience that in a tannery of the importance of yours this work can be carried out to the extent that you have carried it out without ruinous consequences to the trade?—I certainly think so.

10878. (*Sir Michael Foster.*) You have plenty of land there, have you?—We have just enough land for another filter bed. I should point this out, and that is, that we are rather fortunately situated, because the whole of our effluent flows by natural gravitation. Were it not so, we should have been compelled, of course, to have put down a pumping apparatus, which would have naturally increased the first cost; but allowing even for a pumping apparatus, I certainly think that the prime cost is not ruinous for the size of a tannery, and of a business, such as ours.

10879. The addition of a new filter would make you not work your present filters so hard as you do at present, I suppose?—That is so; they would get an additional rest.

10880. It is not to have a second filtration passing through the new bed after it has come out of the old bed?—That would enable us to pass it through two beds instead of through one only, as at present.

10881. That is what you are proposing to do?—That is so.

10882. (*Colonel Harding.*) Then, recapitulating your evidence, you tell us, from your experience of the tanning trade, that you believe it to be quite practicable, within reasonable limits of cost, to satisfy the requirements of the local authority receiving your effluents into the sewers, and also you think it possible—within practicable limits, of course—to so far improve the effluent that it is possible to receive it into a stream which is not used for drinking purposes?—I certainly think so.

10883. (*Chairman.*) May I ask you whether you know whether your effluent has ever been analysed bacteriologically?

10884. (*Colonel Harding.*) I think I can answer that question. I do not think it has been analysed bacteriologically, but very frequently from a chemical point of view by the Rivers Board.

10885. (*Chairman.*) I was only wondering whether anthrax had ever been found.

10886. (*Colonel Harding.*) I do not think there has been any investigation for anthrax, as far as I know?—We have never had a case of anthrax at our tannery—never.

10887. (*Professor Ramsay.*) Might I ask whether you turn away much spent tan in your effluent?—No; it forms a very small proportion of our effluent—the old tanning.

10888. Then, do you find much trouble with the sludge in your filters?—No, the older they get they silt up, and we have to clean them out very much oftener than we did at first.

10889. Does the tan get through your filters? Of course you do not lose much tan liquor, but do you ever test the effluent for it?—The tanning, what small portion does find its way into our effluent, unfortunately colours the whole of the effluent, and our main difficulty at the present time is the colour of the effluent.

10890. I was just thinking it might not have a bad effect on the sewage, because if tan liquor mixes with ordinary domestic sewage, it might very well produce an insoluble compound when it reaches the works. If it does get into the sewage works it comes into contact with the albuminoid matter of the ordinary sewage of the district, and would produce an insoluble precipitate and remove a considerable amount of albuminoid matter?—The tan liquor of the effluent will not form more than 5 per cent. of our volume.

10891. (*Major-General Carey.*) How do you dispose of the sludge?—The farmers carry it away; we give it to them for the carting away.

10892. (*Chairman.*) I suppose you give it to them; they do not buy it?—No, we tried in the first place to sell it, but we found they would not fetch it away to buy it, and so we gave it to them.

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10893. And are they always willing to carry it away?—Oh, yes, whenever it is in a suitable condition for carrying purposes, they are very glad to fetch it.

10894. Might I just ask you whether you take any precautions about anthrax?—Well, we do not deal with the class of hide in which anthrax is found, so that we have no difficulty whatever in that matter. All our hides are fresh market hides.

10895. (*Sir Michael Foster.*) You prepare the sludge for the farmers, do you?—Only that we pump the sludge into rough tanks, and then it simply dries in the open air, and they fetch it away immediately it is fit to cart away.

10896. Would a very large addition to your outlay and annual expenditure for preparing your effluent become unreasonable?—Yes, it might very easily become unreasonable. Of course, we are fortunately situated as far as land is concerned. Some of the tanyards lower down are not so well situated as we are. For instance, I believe at some of the tanyards it would be impossible for them to find room for earth tanks, so that the special circumstances surrounding our own case should be borne in mind in that particular way.

10897. (*Colonel Harding.*) On the other hand, some of the tanneries, where the difficulty arises, have the advantage of drawing water from wells; they are enabled to turn part of their effluent into the sewers?—Into the sewers, yes, and it will be my desire, provided we take a new lease, to suggest to Mr. Nickols that we sink a well in our own yard to enable us to put our effluent into the sewers. In my opinion that would do away with a great deal of difficulty.

10898. There is just another little point which occurs to me. It would be of advantage, would it not, for any manufacturer as far as possible to keep the volume of his foul water as small as possible, and therefore he ought to withdraw from it, for instance, condensed water from his engines?—Exactly.

10899. Whereas in many cases these things all mix together, and go to the stream?—That is so.

10900. (*Sir Michael Foster.*) Is it so in your case?—We do take all ours; condensed water does not go into the effluent at all, we try to keep the effluent within as small a compass as we reasonably can.

10901. (*Dr. Burn Russell.*) Are all your works under the Rivers Board?—Yes, they are all under the West Riding Rivers Board.

Mr. E. Butterworth.

Mr. Enoch Butterworth, called; and Examined.

10902. (*Chairman.*) You are Mr. Enoch Butterworth, trading as David Butterworth and Co., manufacturers of fancy flannels, tennis clothes, etc., at Andrew Mill, Greenfield, in the parish of Saddleworth and county of Yorkshire?—I am.

10903. Could you tell me whether the water used in your works is taken from a stream or not?—No, the water we use for dyeing and finishing is a clean supply, a special supply.

10904. And therefore there is no obligation on you to return it to any stream?—No.

10905. (*Sir Michael Foster.*) None of it?—None of it.

10906. (*Chairman.*) Your effluent is composed of waste water from wool scouring, dyeing, and finishing?—Yes.

10907. And it is estimated to average about 10,000 gallons a day?—Yes.

10908. What do you do to the effluent; do you treat it in any way?—We have a tank under the floor, a receiving tank, to collect the dye water, the finishing water, the effluents. Then we pump it into two large tanks; each tank will hold about one day's effluent. We treat it with lime and alumino ferric. Here is a sample of the crude effluent; here is a sample that has been treated. We treat it with lime and alumino ferric as a precipitant, and it throws it down in this form. There it is. That has been treated. Then we pass it over a filter and run it into the stream in that form. (*Produces samples in bottles.*)

10909. (*Sir Michael Foster.*) What kind of a filter?—A filter composed of clinkers and breeze; it is really broken coke and fine sand.

10910. What are the main impurities of the effluent before treatment?—Before treatment, this will be what we call seak. It will be soap, alkali, some little acid, and dye waters.

10911. Is the reaction strongly acid?—No, it is not very strongly acid.

10912. (*Professor Ramsay.*) Do you recover soap? (*Colonel Harding*) Do you recover oils?—No, we do not recover anything. It is under consideration at the present time.

10913-14. Is it not usual to recover grease from effluents such as yours?—It is in large works, but it will not pay for small manufacturers.

10915. And where the grease is recovered the effluent is usually treated by sulphuric acid, is it not?—Yes, but it is not supposed to be generally satisfactory because of the acidity. There is no standard of purity.

10916. Then in this case is the final effluent from your treatment neutral?—It is pretty neutral.

10917. And the bottle which you show us seems very clear?—Yes.

10918. Is that really a fair sample of what you turn out?—Yes, on an average it is about that.

10919. (*Sir Michael Foster.*) It could not be much better than that in appearance, could it?—There is some little in it, not much; there is some little left, but it is the cost; it is rather costly.

10920. (*Colonel Harding.*) Have you satisfied the West Riding Rivers Board?—Oh, yes, we can satisfy them, but we cannot satisfy ourselves; it is a tax upon our industry.

10921. Are you dealing with the whole of the effluent?—Yes.

10922. Can you tell us at what cost you are dealing with it, if you are at liberty to do so?—The chemicals cost us about 7s. 6d. per week, and if I recollect $7\frac{1}{2}$ per cent. on the cost of our plant, £350. That would be about 10s. per week, and we are rated upon these works at about £10; that would be 9d. per week; the cost of pumping the sewage from the pit into the tanks is about 2s. 6d. per week, and the attendance I estimate at about 5s., so that will total £1s 5s. 9d. per week.

10923. To deal with the whole of your effluent?—Yes, that will be 60,000 gallons per week.

10924. Did I understand you to say that that was ruinous?—Well, it works out this way, that it is 7s. 6d. per cent. on our turnover.

10925. One-third of 1 per cent.?—Yes. It is 7s. 6d. per cent. on our turnover.

10926. But do you not think that even at that limit a manufacturer ought to be able to make the necessary sacrifices to purify his effluent?—He probably could manage, but still he would be much better if the cost could be lessened. It is costing rather too much.

10927. (*Chairman.*) How long has your present system been going on?—I have been working for about three years.

10928. And has the filter cost you much to keep in order?—Yes, we are fast with our sludge. Here is a sample of our magma, if you care to open it and see it. We cannot get rid of our magma.

10929. And you cannot get rid of your sludge?—No.

10930. What do you do with it?—We have it tipped on a large heap. The Council will not have it. They will not find us a tip for it; the farmers will not have it.

10931. (*Sir Michael Foster.*) You cannot persuade the farmers that it is good for their fields?—No.

10932. (*Major-General Carey.*) Do you dig it in?—No.

10933. Is it combustible?—No. Would you like to see it?

10934. I was thinking there was a good deal of grease in it?—There is grease in it, but I do not know in what form; perhaps you professors could tell me in what form it is.

10935. (*Sir Michael Foster.*) You have not tempted any of the farmers to make any experiments with it?—They have tried it.

10936. (*Colonel Harding.*) Have you tried to burn it? It takes coal to burn it.

10937. It might be worth while to test as to its value as a fuel by mixing it with coal?—We have tried it.

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10938. Do you not think it has any fuel value?—Not until it is very dry, and it takes coal to dry it.

10939. It would not be worth while to press it into a sort of cake?—If we did that we might as well put our recovery plant down complete.

10940. How much lime and alumino-ferric do you use per thousand gallons?—We use about half a hundred-weight of alumino-ferric per day, and about a quarter hundredweight of lime. There is a large percentage of lime in that.

10941. You have no arrangement for artificial drying; you have no waste heap of any kind?—No, we have not.

10942. What is the nature of the soil about your works?—Clay.

10943. How do you light your works?—With gas.

10944. Can you not make gas enough from your sludge to light your works?—I wish you would show us how.

10945. If you dried it and distilled it, you could perhaps burn it?—Yes. I say it will burn if you dry it very hard, but our district is not a very dry district; we cannot dry it.

10946. (*Sir Michael Foster.*) What is the stream into which you throw; is it a large stream, or a little stream?—No, it is only a small stream. It varies very much acording to the season.

10947. (*Major-General Carey.*) Why are you not satisfied with the effluent?—We are quite satisfied with the effluent, but we are not satisfied with the cost of producing it.

10948. (*Colonel Harding.*) You did not give us the capital cost of your plant; you gave us the cost of working?—£350.

10949. That was the capital cost?—Yes, not including the cost of the land. The cost of erection was £350.

10950. You had the land, I suppose?—Yes.

10951. And your interesting evidence amounts to this, that in your particular trade you have found it possible to so purify your trade wastes as to satisfy the Rivers Boards at a cost of £350 for capital, and at an annual cost of one-third of 1 per cent.?—That it so.

10952. (*Sir Michael Foster.*) There are no sewers, I suppose, into which you could discharge your effluent?—Yes, but the Council did not calculate upon mills turning in when they made their sewers.

10953. And the sewers as at present constructed are too small?—They are too small.

10954. Is that the reason why you have not passed your effluents into the sewers?—We asked them before we erected our filters. Of course, they give us the same answer as the others, that they were not calculated to take the mill effluent.

10955. Not calculated by size?—By size.

10956. Not on acount of the nature of the effluent, but simply of the volume?—No; the volume.

10957. (*Chairman.*) Then I understand that you consider that the authorities ought to allow you to use a public tip for your sludge?—I do.

10958. And also that you ought not to be rated on your outfall works?—I think that is very unfair.

10959. And you consider, generally speaking, that the law ought to be altered so as to give manufacturers greater rights than at present to connect with the sewers?—Only for a small manufacturer.

10960. (*Sir Michael Foster.*) Because he simply does less damage?—He does less damage, and most of them would not have capital sufficient to put down a plant.

10961. And if the small manufacturer had greater powers to turn his refuse into the sewer, do you consider that there ought to be any further safeguards to secure that the refuse shall be delivered in such a condition, and in such regular quantities, as that it would not interfere with the purification of the sewage?—Well, in small ones you would not require such restrictions, but it would be a breach of riparian ownership if they were allowed to, and I think there ought to be some consideration paid to riparian ownerships below.

10962. Would your experience enable you to give us any idea of what you think the best kind of safeguards should be?—In turning in.

10963. The best sort of safeguard for preventing the trade refuse getting into the sewers in such a condition as will interfere with the purification of the sewage?—I could not suggest anything for a small man, because he would not damage them in any way. Anything a small man might turn in (in any way) would not damage them. It is the larger ones that would damage.

10964. There is a question of the regularity of the supply?—Yes.

10965. Now do you think measures should be insisted upon for ensuring a greater regularity of the flow turned into the sewer?—That is so.

70966. By constructing a receiving tank?—Yes, a receiving tank.

10967. And you think that that might very justly be insisted upon?—I think so.

10968. In the case of large manufacturers only?—In the case of large manufacturers only; small manufacturers would not damage the outfall works of an urban or a rural council, neither as to quality nor quantity.

10969. (*Chairman.*) Do you think the manufacturers would be prepared to adopt means to remove solids and grease?—Yes, if they knew what to do with it when they had taken it out; they are stuck with it at present.

10970. Do you yourselves try to recover any part of the refuse for use?—We have a scheme on hand now, a combination of manufacturers. We are intending to combine ourselves for the recovery of fats, but we cannot satisfy ourselves yet as to what standard of purity the Rivers Board would require from us, or how to go about it.

10971. (*Sir Michael Foster.*) You cannot satisfy yourselves; do you mean that the Rivers Board are unable to tell you?—They are unable to tell us, and we have not yet formed ourselves; we have had two meetings already—21 millowners.

10972. And you have not yet settled upon what you consider an adequate process?—We have not.

10973. (*Colonel Harding.*) Are those mill owners personally in the same business as yourself?—Practically.

10974. And turning out effluents which could be treated in this way, which you have explained?—They could not all get them quite as good as that, because of the amount of dye water.

10975. With that exception they could?—Our dye water will average about six per cent.

10976. (*Sir Michael Foster.*) This is a small relative quantity?—It is a very small relative quantity; six per cent. of dye water; the more dye water you have, the worse it is, of course, to treat.

10977. You said that you have so little dye water?—Our goods are of a light colour, because we use very much white material.

10978. And that puts you under very favourable circumstances?—Yes.

10979. (*Major-General Carey.*) Have those effluents ever been analysed?—These samples have not.

10980. No, but the effluents from the tanks?—They have taken samples for the West Riding Rivers Board; they have not reported to us in detail.

10981. You have not analysed them yourselves?—They have not reported to us officially; Dr. Wilson told us our effluents were practically neutral.

10982. (*Colonel Harding.*) Then anyway the Rivers Board is not pressing your firm to do anything more than you are doing?—Oh, they are quite satisfied.

10983. They are quite satisfied?—Yes.

10984. What is the difficulty in the way of the 21 manufacturers doing the same in either a joint works or at separate works?—We cannot have joint works, not to filter jointly; we could have a joint scheme for recovery.

10985. For recovery, but not for filtration?—But not for filtration.

10986. Then what is the difficulty in the way of other manufacturers on your stream doing what you are doing?—In one or two cases the difficulty is shortness of room.

10987. They have no land?—No.

10988. But would it not be possible for two or three of them, at all events, to combine for the purpose of carrying out this filtration and settlement?—Well, in one case riparian ownership would step in; they would have to pass the mill-owner below, and it would be a loss of power.

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10989. What are the names, may I ask, of the two large firms on your stream that you refer to?—One is Greenfield Mills Company, Limited, cotton-waste bleachers for the War Office; I presume it is intended for gun-cotton; and the other is Butterworths, of Junction; they are printers. It seems impossible for the Greenfield Mill Co. to purify their large volume.

10990. Then are we to take it that this association is being formed for the purpose of endeavouring to find a solution to the difficulty?—In the woollen, but not in these large volumes (the Greenfield Mill Company and Butterworths).

10991. (*Sir Michael Foster.*) They do not enter into this combination?—They are not entering into our combination at all.

10992. (*Colonel Harding.*) So far as you know, are they doing anything to try and satisfy the Rivers Board?—Yes; they are doing all they can. Still, their effluent, when they have done their best with it, is certainly bad.

10993. But possibly they simply settle, and do not filter?—They have three or four acres of filters or tanks.

10994. Is it recent work which they have carried out under pressure from the Rivers Board?—Yes.

10995. Are the works in full operation?—Yes.

10996. You have no personal knowledge as to whether they satisfy the board or not?—I do not think they are doing; the board have no standard of purity. If you could recommend some standard of purity we could all, perhaps, satisfy them.

10997. But has a standard of purity been settled in your case?—No.

10998. Nevertheless, without such standard, you see they are apparently satisfied with what you are doing?—Yes: they may be satisfied, but we are not, because of the cost. It would reduce the cost a little if we could allow a little more to go.

10999. (*Chairman.*) Do you think that there ought to be a tribunal to whom an appeal could be made if the local authority refused to allow trade refuse to go into the sewers?—No; I do not think so; only in very special cases.

11000. (*Sir Michael Foster.*) You think it is better to settle disputes at a court of law?—Yes.

11001. You prefer that method?—Yes, I should prefer an arbitration before taking it to the High Court; but if the local bench or the local judge could not settle it, then I should say settle it by arbitration. The High Court is rather an expensive luxury.

11002. (*Chairman.*) And do you consider manufacturers should be required to pay a special rate when they are allowed to connect with the sewers?—Yes, if they are freed from cost of chemicals or of special appliances. I have made some inquiries from the next mill-owners in the Mossley Corporation district. There are two or three mill-owners which turn direct into the sewers, and I believe they pay £40 per annum for the privilege; they turn it in in its crude form.

11003. What are the reasons mostly given by local authorities for refusing to allow trade refuse to go into the sewers?—I can only speak for our own; that the sewers were not calculated to take mill effluents because of their size, their capacity.

11004. They are not big enough?—Not big enough.

11005. Are there any particular difficulties that you know of that a manufacturer usually meets with in dealing with local authorities?—No; there are no special difficulties.

11006. (*Sir Michael Foster.*) But the want of a standard, I understood, you considered a difficulty?—Are you now referring to the local authority or the Rivers Board?

11007. (*Chairman.*) I mean the local authorities?—The local authority. Well, I do not think there is much difficulty, because they put it very plainly; their sewers are not calculated to take mill effluents. The difficulty with the Rivers Board is that they have neither standard of purity for suspended matter nor standard of purity as to acidity.

11008. (*Sir Michael Foster.*) You prefer a general standard which would be applicable to all, irrespective of their individual circumstances, rather than that each case should be judged on its own circumstances?—We should prefer a general standard.

11009. (*Colonel Harding.*) Are you quite sure that a general standard of that kind would help you; would it not be necessary for a Rivers Board making a standard, if they thought wise to do so, to name a standard which would be so high that it might involve you in greater cost than if there were no standard? Are you quite wise in pressing a Rivers Board to name a standard?—I think so. If you adopted a standard, you would not adopt one of those standards (referring to sample); it would be better for us.

11010. If the standard were a higher standard than you have now reached?—Well, you could not possibly get one, I think, above that sample.

11011. (*Chairman.*) What would be the effect upon the flow of water in streams if trade refuse were diverted from them into the public sewers; and would you consider any alteration in the law which would permit of the abstraction of dirty water from the streams is desirable?—If the dirty water were abstracted from the streams the streams would be very much reduced, particularly in the summer time; there would be very little water left in the dry season.

11011.* (*Sir Michael Foster.*) Is the stream into which you discharge your effluent a fairly clean stream, or already somewhat defiled?—Oh, it is very much polluted by those 400,000 gallons.

11012. (*Chairman.*) Is the 400,000 gallons that you speak of the first pollution on the stream?—Yes, the first on the stream.

11013. (*Professor Ramsay.*) Is it dye water?—Bleach water from the bleach waste in preparing it for gun-cotton.

11014. (*Chairman.*) And what sort of size is the stream at the point where this first pollution takes place of the 400,000 gallons?—Well, I can hardly answer that; but we get 932,000 gallons per day compensation water when they have it, but last summer they failed to send it; the reserve was absolutely empty.

11015. Then the stream would be quite small?—In the summer months it is very small; a child might very easily walk across it.

11016. (*Dr. Burn Russell.*) Do you pass that clear effluent that is on the table into this foul stream?—Yes.

11017. And is this foul stream under the jurisdiction of the same Rivers Board?—Yes, the same. That is where we think there is a gerat injustice; ours going in so clean, the others going down so polluted; we are actually doing all we know.

11018. (*Colonel Harding.*) But did we not gather from you just now that the Rivers Board are pressing the manufacturers above you?—They are pressing.

11019. And that they were carrying out some works?—They are working daily at them.

11020. So that there is a prospect of the stream above you being gradually improved?—Some little, not much.

11021. (*Dr. Burn Russell.*) How long have you been passing that clean effluent into the stream?—Ever since we started the filters.

11022. How long?—Three years to $3\frac{1}{2}$ years.

11023. And during that time has there been any substantial improvement in the quality of the stream?—There is only this one firm above us polluting; we are the second taking.

11024. But during the three years you have been sending this clear effluent the brook has been uniformly polluted?—Yes, there has been very little change with the Greenfield Mills Company.

11025. What makes you so hopeless about the Greenfield Mills Co.?—The nature of the effluent.

11026. You do not think it is practicable to do it at all?—No; not to this standard.

11027. Then you are setting a standard, so far as this brook is concerned?—I am setting a standard for ourselves.

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11028. (*Sir Michael Foster.*) Yes; your view is that the standard which is possible for the works above you should be accepted as your standard?—In all fairness it ought to be.

11029. (*Colonel Harding.*) Do you really think that it is not practicable for them at any cost to purify their effluent?—To do——

11030. At any cost, is it not possible to be done?—It would be prohibitive; they would have to stop.

11031. The cost would be so great?—So great.

11032. Have you gone into the matter yourself?—It is the nature of the effluent—caustic, soap, and grease; it is a peculiar effluent.

11033. Is it not possible to treat it chemically so as to gradually improve it?—Well, from our own little experiments in our laboratory, we do not think it is possible commercially to do it.

11034. (*Sir Michael Foster.*) You have made some experiments with your effluents, have you?—Yes; we have tried the action.

11035. (*Dr. Burn Russell.*) You say there is 6 per cent. of dye water in your discharge?—In ours, yes.

11036. Then to what extent does that contribute to the difficulty in treating your total discharge?—I hardly follow you there.

11037. You allow your dye water to mingle with the total of your discharge before you deal with it at all?—Yes.

11038. Well, to what extent does the presence of this dye water add to the cost of producing such a clear effluent as that?—It is the alkaline and analine dyes which are rather hard to precipitate.

11039. Could you not deal with the dye water apart?—No.

11040. You cannot?—No.

11041. What is the difficulty?—The construction of the works; the collecting of it.

11042. Does that apply to the other manufacturers of whose discharge this dye water constitutes a much larger proportion?—I could not answer that. I do not know the construction and the nature of their works.

11043. That seems to point to the advantage the manufacturer himself has owing to his intimate knowledge of the constitution of his discharge in dealing with it economically?—I daresay it is some advantage.

11044. But still, you do not in the construction of your works think that you could advantageously deal with this element of dye water without allowing it to mingle with the total discharge, and increase the difficulty of dealing with the whole quantity?—No, the construction of our works would not allow it.

11045. Are those 21 manufacturers near each other so that they can with facility combine?—No; Saddleworth is very scattered; the mills are very far apart in some cases.

11046. Then did you propose to run the discharge of all these 21 manufacturers together?—We proposed to collect the magma, the solids from each mill, and put a central works down for pressing.

11047. To utilise it?—To utilise the fats.

11048. To put the whole lot together so as to get any commercial advantage that was to be had?—That is so.

11049. (*Colonel Harding.*) Then any way they would have the seak tanks and keep out as much grease as possible?—They would have to extract all the grease they could in that case.

11050. Do you know any process by an inventor, Mr. Turner, by which it is alleged a large proportion of grease can be extracted?—Yes. We had an interview with him last Monday week; the whole of the manufacturers in the district.

11051. Are you likely to experiment in that direction?—The effluent is largely on the acid side.

11052. But it would not be a prohibitive cost to treat with alkali and a settling tank?—So they argue, but the cost then would take away all the profit. If there was any it would take it away—the cost in second treatment.

11053. (*Sir Michael Foster.*) I forget whether you told us the nature of the filter through which you pass your effluent?—It was made under Mr. Oddy's plans, of Rochdale. The body is large clinckers, 4 or 5 inches thick; on the top of that 3 or 4 inches of smaller size, and on the top again 2 or 3 inches of coke breeze, with some sand.

11054. That has been working now some three years?—$3\frac{1}{2}$ years.

11055. Have you renewed it at all?—Oh, yes; we have renewed the breeze, the top coating.

11056. To the depth of how many inches?—About 3 inches.

11057. How many times have you renewed your bed?—Only once.

11058. Only once in three years?—Only once in the three years have we took it up, but we have forked it over.

11059. (*Major-General Carey.*) Do you filter continuously through the filter?—Yes.

11060. Night and day?—We are not working in the night.

11061. (*Sir Michael Foster.*) You have just forked it over. There was a little clogging before you forked it over?—When there is a little clogging of the coating or breeze on the top, and we fork it over.

11062. How often do you fork it over?—About once a week.

11063. And with that the filter remains effective?—Yes.

HERBERT A. FOSTER, called; and Examined.

Mr. H. A. Foster.

11064. (*Chairman.*) You are a managing director of Messrs. John Foster and Son, Limited, Black Dike Mills, Queensbury, near Bradford, alpaca and mohair spinners and manufacturers, a Justice of the Peace for the West Riding of Yorkshire, a member of the West Riding of Yorkshire County Council, Vice-Chairman of the Manufacturing Pollutions Committee of the West Riding of Yorkshire Rivers Board, Chairman of the Queensbury Urban District Council, Chairman of the Queensbury School Board, a member of the Council of the Bradford Chamber of Commerce, and a member of the Institution of Mechanical Engineers?—Yes.

11065. How much trade effluent discharge are you prepared to speak of from your own knowledge?—44,000 gallons is the amount of the trade effluent which we deliver from our works daily—about.

11066. Is the water from your works taken from a stream?—No, it is all pumped and softened. It is water of considerable hardness; it varies from 12 to 15 or 16 degrees, and we soften it all and use it for our manufacturing purposes after softening.

11067. Then there is no question arising about your being bound to return it to any stream?—No. I might say that we are 1,100 feet above the sea level, so there is no stream except what comes from the top of the hills. We are at the top.

11068. Then where does your effluent go to?—Our effluent is discharged into the sewers of the Queensbury Urban District Council after we treat it.

11069. In what way do you treat your effluent?—We use lime and alumino ferric. The quantity varies in accordance with the effluent that we have to treat. Sometimes we use more lime or more alumino ferric in accordance with the dyewares which we use in our dye works, and in accordance with the effluent that we are discharging.

11070. (*Sir Michael Foster.*) The constituents of the fluid are, I suppose, grease?—I perhaps ought to explain that we have a dye works, and we have our wool washing. The wool washing is all treated by seak tanks in the usual way, and goes into the same tanks as the effluent from the dye works.

11071. So that what are the main constituents of the effluent before treatment with the lime and the alumino ferric?—The water from the seak tanks, of course, as usual, is acid.

11072. And still contains some fat?—Very little.

11073. Very little?—Very little indeed, nothing that we find any trouble with.

11074. Then is it the dyes that are the chief trouble?—Yes, the dyes are the chief trouble as a rule.

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11075. (*Colonel Harding.*) Do we understand that previous to treating with lime and alumino ferric you have the seak tanks?—Yes.

11076. In which the liquor is treated by sulphuric acid?—Yes, in the usual way.

11077. Then it is really the liquor from the seak tanks which is treated with lime and the alumino ferric?—Yes; along with the dye waters.

11078. (*Sir Michael Foster.*) The lime is partly for neutralising the acid, I suppose, and also for assisting in the treatment of the dye?—Precipitation, yes; the action of alumino ferric and lime; it is better when the two are used together. At first we only used lime about a ton per million gallons, but now we use perhaps five or six hundredweights of alumino ferric along with it.

11079. With much better results?—With much better results.

11080. (*Chairman.*) And do you get a large amount of solids?—We gather on an average about six hundredweights a day. The tanks precipitate the sludge, we let off the clear water from the top, the sludge goes down into a boiler, and we have compressed air which we blow into the boiler, and the sludge is then made into cake by means of filter presses. The weight of the cake per day is about six hundredweights.

11081. And what do you do with the cake?—The cake is valueless. We have had it analysed, and it is of no value whatever. We mix it up with soil and put it on the land.

11082. (*Sir Michael Foster.*) Your own land?—Yes.

11083. It increases the bulk of the land, nothing more?—That is about all, sir.

11084. (*Professor Ramsay.*) Is the effluent colourless or is it still coloured with dye water?—It is not colourless. It varies in accordance with the dye wares that we have to use. Some dye wares are very difficult to treat, to get them colourless, but we have no complaint from the Urban District Council, who take our trade effluent into their sewage works.

11085. Do you deliver the effluent to the sewers gradually or does it come in rushes?—No, we treat the whole of our effluent as far as possible gradually. It comes in rushes into our tanks, but there is a general flow from the works during the day.

11086. (*Colonel Harding.*) What is the nature of the treatment adopted by the Urban Council for the sewage of which this forms a part?—It is also treated there with alumino ferric; the domestic sewage and the whole of the trade effluents that come to the District Council are treated by means of alumino ferric.

11087. (*Sir Michael Foster.*) And no further treatment?—And filtered over the land.

11088. How?—In the usual way.

11089. (*Colonel Harding.*) And what is the relative volume of the domestic sewage treated by this Urban District Council and your trade effluent?—The volume of sewage of the District of Queensbury amounts to about 80,000 gallons per day in dry weather. We send down about 44,000 gallons a day, a brewer sends down about 6,000 gallons per day—I rather estimate that it is more than 6,000 myself, but these are the figures that were given to me.

11090. (*Sir Michael Foster.*) And the remainder is domestic sewage?—And the remainder is domestic sewage.

11091-2. (*Sir Michael Foster.*) The total is 80,000?—The total is 80,000 in dry weather, and we have 44,000.

11093. (*Chairman.*) You and the brewery supply 50,000 of that?—And the brewery, yes, about 50,000.

11094. Then less than half is domestic sewage?—Yes, less than half.

11095. And that 80,000 is ultimately treated over land?—Over land.

11096. You have had no difficulty with the local authority yourselves; but do you consider, generally speaking, that the position and the rights of manufacturers and the local authorities under the existing law are fairly defined?—No, I do not consider that they are clearly defined, and I think that the local authority ought to be compelled to take in the trade effluents of a factory providing that it has had proper preliminary treatment. I believe that there is no law which can compel a local authority to take it at the present moment.

11097. (*Colonel Harding.*) Would you compel an authority then even if they had not a sewer large enough to take it?—Well, that opens out a great question. I consider that a local authority ought to take from existing works the trade effluent providing it is properly treated.

11098. (*Chairman.*) Irrespective of size and amount?—If the amount is excessive, then I think that the manufacturers ought to in some measure bear some cost.

11099. (*Sir Michael Foster.*) What do you mean by "excessive"; do you mean in proportion to the other supply of sewage?—In proportion to the total sewage of the district.

11100. (*Major-General Carey.*) Is not regularity of flow important to the local authority who has to treat this volume of trade water with sewage?—Yes, I consider that it is highly necessary.

11101. In all cases?—It should be a steady flow in order that any works can do their work efficiently.

11102. (*Chairman.*) Then for the kind of works such as yours, do you think it practicable to carry out this preliminary treatment, and also to turn out a regular flow within reasonable limits of cost?—Yes, I do.

11103. (*Professor Ramsay.*) Is there a profit made upon the fat extraction?—Very little; it greatly depends upon the class of wool that the manufacturers are using. Some wools have as much as 30 per cent. of grease in them. In the wools which we use, that is alpaca and mohair, there is practically no grease at all; the amount of grease that we recover is merely the soap that we put into it to wash it. I do not suppose really that we make any profit at all in recovering it.

11104. But you do not think you lose?—No; I do not think we do. I think it is a right thing to do.

11105. (*Sir Michael Foster.*) Would it be fair to ask you what is the cost of the preparation of the sewage, what it entails upon you; what proportion, for instance, of your turn over?—I could not give you that straight off, sir; but, speaking generally, I estimate that it is nothing which is an injustice to a manufacturer that he should be called upon to treat his effluent.

11106. (*Chairman.*) Your trade refuse, has it always gone in the sewers of Queensbury may I ask?—Well, I should have to go back some years to answer that question. We made our works for treating our trade effluent before the District Council had any sewage works of their own; and, to begin with, we actually treated the sewage belonging to the District Council in our works. It was not efficiently treated, of course, the same as it is now, but still we gave it the preliminary settlement, and we used lime, and it was mixed along with out trade effluent before it went down into the stream.

11107. (*Sir Michael Foster.*) There is a stream there, then?—Yes, there is a stream.

11108. (*Chairman.*) Then in your case your trade refuse was there before the sewers were constructed which now take it. I mean it was not a case of bringing it into existing sewers, but the sewers were built knowing that your trade refuse would come into them?—Yes.

11109. (*Sir Michael Foster.*) The sewage was brought to your works by the sewers, was it not?—Yes, we took it out of one of the sewers to treat it; it was only a small quantity before we got the whole district properly sewered.

11110. (*Chairman.*) The question did not arise with you of having to turn a large amount of trade refuse into very small domestic sewers?—No.

11111. That is where the difficulty seems to me to come, a large amount of trade refuse wanting to go into the sewers of a local authority which are not big enough?—There is certainly a difficulty, but in an ordinary way, if the flow from the works is regular there is no need for any great difference in cost to the local authority in making their sewer large enough to begin with.

11112. No, not if they know in time; but I mean where the sewers are constructed without having considered this trade refuse, and then a new large amount of trade refuse wants to go into them, the difficulty arises at once?—I admit that is the difficulty.

11113. (*Sir Michael Foster.*) It does frequently occur, does it not, that the local authorities refuse to take the refuse because they say their sewers are too small?—They may do, sir, but it has not come practically under my knowledge; at least, it has not come before me.

11114. (*Chairman.*) Do you not know of any case where that has happened?—I do not for the moment.

11115. (*Sir Michael Foster.*) When you took the sewage and treated it with your own effluent, you returned it into the stream without land treatment?—To begin with.

11116. Since then?—Since then there has been a large sewage works constructed, and with land treatment.

11117. With land treatment, and then you turned your purified effluent into that general system?—That is what we do.

11118. (*Major-General Carey.*) The local authorities have no difficulty in treating combined sewage and trade refuse?—No.

11119. (*Sir Michael Foster.*) Was it tolerably successful your treatment of the sewage and your own refuse when you turned it into the stream, or did you pollute the stream?—I could not say that it was a good effluent, but it was very much improved, because before it had no treatment whatever.

11120. (*Chairman.*) Then, if I understand you rightly, you are inclined to think the local authorities ought to take trade refuse?—If efficiently treated.

11121. If it is efficiently treated, and if the flow is regular, they ought to face the difficulty of not having a sufficient existing accommodation in their sewers to take it?—I think that is not unfair.

11122. And that if they have to enlarge their sewers or make new sewers to do it, that the manufacturer might be called upon to pay a portion of the cost?—He might be, if he is not already, in the way of rates, paying a very large proportion of it. In our own particular case we pay half the rates practically, that is, we pay 7-16ths of the rates, and so all the money that is spent by the local authority is, practically half of it, provided by us as manufacturers, and the District Council collect the rates from us, so my point is if a large manufacturer pays half the rates that he is entitled to have consideration in having sufficiently large sewers provided for his trade effluent.

11123. Would you say that it was desirable to have any standard up to which a manufacturer might be required to work?—No. I should say not, and, speaking as a manufacturer, I should much prefer not. The Rivers Board or the authority that have these matters in hand I think are reasonable, and if an actual standard were fixed it would probably be worse for a manufacturer than having it as it is now.

11124. In the event of the local authority and the manufacturer differing as to whether the manufacturer brought his effluent into such a condition as it might be turned into the sewers, would you have any body who could decide such a question?—Yes, I should certainly prefer to have a properly constituted body to deal with such as either the Rivers Board or some central authority, which could consider and settle these matters at once. When I say "settle," I mean that it should not go before the Local Government Board, and be a matter which hangs on for ever. It should be that it comes before a number of practical men, and that it is settled forthwith.

11125. (*Sir Michael Foster.*) Did you read our interim report?—I did not read it all, sir. I only read parts of it.

11126. The suggestion is there made for a supreme rivers authority, which should be a court to decide as rapidly as possible all such questions?—I should consider that a good thing; I should have no objection myself as a manufacturer in going before them.

11127. (*Professor Ramsay.*) We have had a good deal of evidence to the effect that the manufacturers wish to have a standard, because they say there is no finality if there is no standard—that they do not know what to aim at, and that therefore it prevents them from doing anything?—Well, I am afraid I cannot agree with the previous witness.

11128. (*Chairman.*) Should you say that manufacturers generally were prepared to adopt means for removing the suspended solids and grease, etc., from their trade refuse before being allowed to discharge it into the sewers?—Yes, generally I think so. As a member of the Rivers Board I may say that I often speak to manufacturers and try to influence them with regard to these matters, and, taking it generally, I think that the manufacturers are reasonable and willing to do what they can.

11129. And do you think, on the whole, that they are willing to dispose of the solids themselves, or do they expect that the local authorities should help them to dispose of them?—That is a somewhat difficult question for me to answer. My experience as a member of the Rivers Board is that some of them wish to do nothing at all, and if they can get the local authority to take the sludge, of course they would only be too willing.

11130. I suppose you very seldom find that the sludge is considered worth anything?—Very seldom. The difficulty about the sludge is that it takes up so much room. There is, of course, a means of treating it, such as we use ourselves, that is, by means of filter presses and compressed air, but I should hesitate to ask a manufacturer to put down such a plant, as it is rather an expensive one. We were fortunately situated; we had compressed air in our works, and we simply made use of it.

11131. (*Sir Michael Foster.*) And then you have spare land on which you can deposit this compressed stuff?—Oh, yes, it is all put on to a heap, and then it is put on to the land afterwards, as it is wanted.

11132. In a good many cases the manufacturers have not land to put it on?—No. The bulk of it, of course, is very materially decreased by being put through a filter press, and it makes it easier to handle the cake. You can handle it quite easily.

11133. (*Chairman.*) What would you say the difficulties are that the manufacturers usually meet with in dealing with local authorities, and what are the reasons that are generally advanced by local authorities for refusing to allow trade refuse to go into the sewers?—Well, I should say, speaking generally, that the difficulty that the local authorities have, is that a great many manufacturers want just to turn their trade effluent into the sewers without treating it previously, which I do not consider right.

11134. Then your experience seems to be that it is more a question of treatment than it is of volume. I mean the difficulties arise more often because the effluent is not properly treated, than because the effluent is too large for existing sewers?—I did not quite catch that, my Lord.

11135. I mean your experience is, it seems to me, that where local authorities and manufacturers do not agree it is oftener because the manufacturers will not purify sufficiently, than it is because manufacturers have too much in volume for the local authorities to treat?—Yes; I should say so, but from my own personal knowledge, excepting what I think generally, I could not make that as a statement.

11136. No; but I mean from your own experience?—Yes, I believe that would be so.

11137. And what would be the effect upon the flow of water in the streams if the trade refuse were diverted from them into the public sewers, and is any alteration of the law so as to admit of the abstraction of dirty water from the streams desirable?—The diversion of the trade effluents from the streams in many cases would mean that the streams would be practically dried up, and the streams themselves would not be able to be used for trade purposes. Practically, it would mean closing a number of works upon the stream, if such a thing were possible as to divert it into the sewers—the quantity.

11138. (*Sir Michael Foster.*) That is the bulk of the water, quite irrespective of whether it is clean or dirty; it applies equally whether the water is clean or dirty?—Yes, whether it is clean or dirty.

11139. You think the refuse should go into the sewers in all cases?—I think a great deal depends. Supposing a new works were brought into a neighbourhood, which was purely agricultural, or residential, then the manufacturers would not be justified in asking the local authority to treat several times their own volume of sewage.

11140. In such a case you think it ought to be treated quite independently?—I think that the manufacturer coming into a district, under those circumstances, ought to provide for the treatment of the trade effluent, or that he ought to pay some rate in aid.

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11141. More than the rate which would naturally lie upon him? You say, in your case, you pay about half the rate. Would you have an additional tax to that?—It altogether depends upon the amount of sewage. For instance, if you take a large dye works, if they were started in a new neighbourhood, which was agricultural, or residential, well, they might be using a million gallons of water a day, which it would not be fair to ask the local authority to take.

11142. I mean their share in the rate would not correspond to that?—No, it would not.

11143. (*Colonel Harding.*) It must be a matter for mutual arrangement and agreement between the manufacturers and the local authority?—Mutual arrangement. Yes, that is what I think it ought to be, because, if the new works were brought into either a residential or agricultural district, it would be in order to evade rates or something else elsewhere, and if it pays them to come into a district, they ought also to pay for their trade effluent—a proportionate amount.

11144. (*Sir Michael Foster.*) That is rather an additional argument that all cases should be considered and settled separately?—Separately.

11145. Without either standard as to quantity or quality, and so on, being admitted?—That is what I should say, sir.

11146. (*Colonel Harding.*) In answering the Chairman's question just now, you told us that the manufacturers generally, you thought, were willing to adopt preliminary treatment for the removal of solids before turning their trade effluent into the sewers. I am inclined to think, Mr. Foster, that you have been influenced by the readiness of your own firm to fulfil its duties, but as a member of the Rivers Board, I think you must have experienced that many manufacturers do not want to carry out any treatment at all, and seem to consider that any expense whatever is too great?—That is so, sir. But whenever I go to talk to a manufacturer, and I say to him, it is a great shame that these streams are polluted in the way in which they are, they all agree with that, but when they are asked to do something special themselves, then the objection comes in that it costs them so much money. I think they are in favour of it as long as it does not touch their pockets too much.

11147. As a fact, many of them have formed associations, which have endeavoured, as far as possible, to stop anything being done—is not that so?—That is so, and I regret very much that it should be so, that manufacturers should combine to evade the law, which they ought to carry out and do their duty. It is unfair that one lot of manufacturers should spend money freely to purify their trade effluent, and that the others should not come into line, and be at the same cost.

11148. Then do you not think that, under the pressure of public opinion, and of Rivers Boards, and other authorities, manufacturers are beginning gradually to realise that they must consider the treatment of effluents as a necessary incident in the cost of carrying out their business?—Yes.

11149. And your opinion, which you have already expressed, was, that in your own business you think the purification of the trade effluent to a sufficient extent to enable it to be received into the sewer can be carried out at a reasonable cost?—I do.

11150. On the other hand, where, owing to riparian rights or otherwise, or the absence of sewers, the effluent must go back to the stream, it is difficult to say whether the cost might not, in certain cases, be really prohibitive, the cost of purifying it sufficiently to turn it into a stream so as not to interfere, for instance, with fish life—that is a much more serious matter any way?—It is very difficult for me to say when the cost is prohibitive to a manufacturer. A great many manufacturers can well afford to do it, and, as you have already stated, they avoid doing it, and I regret that they do.

11151. (*Sir Michael Foster.*) I was just going to ask you—you used the phrase "cost too much." In a previous answer, I think you used the phrase?—Well they consider—I think I ought to have qualified it—that it costs too much

11152. That is the point. I rather judge from what you say that a very large amount of effort might be made in the way of purification without any real interference with trade by reducing profits?—Yes, I think so.

11153. But exaggerated statements have been made as to the prejudicial influence of such measures upon the prosperity, for instance, of this and that industry?—Yes. I think that a great many exaggerated statements are made, and I have heard them personally, as a member of the Rivers Board, when manufacturers have come before us. I have heard statements made, which I entirely disagree with, with regard to the cost of purifying their trade effluent, with reference to the size of their business. I know, from my own experience, that such extra cost would not be of that importance as really to interfere with the business which was carried on in the ordinary way.

11154. (*Dr. Burn Russell.*) You think it is of very great importance that there should be equality of treatment of manufacturers, not only within the district of a Rivers Board, but generally throughout the country?—Yes.

11155. As a matter of fairness?—I think so.

11155*. Manufacturers find themselves handicapped by being within the district of a local authority that insist upon a very high standard competing with another manufacturer, who is not so pressed at all?—There is unfairness, no doubt, in some cases from that.

11156. I have formed the impression, from the evidence of other manufacturers, that they feel that to be a great grievance in these keen competing times?—No doubt there is some grievance in that way.

11157. Have you any nuisance arising from your sludge at all?—No, not the least. After it comes out of the filter presses it is practically dry, and there is no nuisance from it whatever.

11158. Is it stored preliminary to being pressed?—What happens is the filter presses have barrows, which we put underneath them; the filter presses are opened, the cake drops into the barrows, is wheeled into a cart; the cart is taken up into a field, where we have soil and other trade refuse, and it is all mixed up together. There is no moisture in it, and, consequently, no tendency to be a nuisance in the neighbourhood.

11159. It would be in storing the sludge that the nuisance would be most likely to arise?—Yes, that is so.

11160. What are seak tanks?—Tanks which the wool washings are sent down into, and they are treated with acid; the acid overcomes the alkali, and the grease comes to the top, or is taken down to the bottom of the tank in some cases, but the usual process is the acid overcoming the alkali, cracks the grease out of the water, and the clear water is let off at the bottom, and the grease is collected and allowed to go into the filters, where it dries partly, and then is put into presses with steam and the grease pressed out.

11161. It is not a part of the apparatus of your manufacture, but merely for the recovery of this grease?—It is purely for the recovery of this grease—yes.

11162. (*Chairman.*) I suppose there are no cases where a local authority comes in and relieves a manufacturer of his sludge, are there?—I have not heard of any. At our sewage works at Queensbury, for a long time, the farmers did not appreciate the value of the sludge, but of late, I am glad to say, they have found out that it is valuable, and they are carting it all away as fast as it is being made.

11163. At your own works?—No, at the sewage works of the Queensbury District Council.

11164. Because I was thinking whether, ultimately, you might come to any sort of scheme by which local authorities would remove valueless solids in the same way that your dustman removes your rubbish in towns?—Speaking as a manufacturer, I should agree with that, but, as chairman of our District Council, I should object.

11165. Because of the expense?—Because of the expense.

11166. Something has got to be done with the sludge, and, if the manufacturer would get all his solids out of his effluents in cases where an effluent went into a sewer, you would be saving the local authorities the trouble of having to deal with them there?—I am afraid that if the local authority were to undertake to take away the trade refuse from works it would be ——

11166*. The solids—the sludge?—The solids, yes, I beg your pardon. If they were to take away the solids, I am afraid that they would often be in such a wet state that it would be almost impossible for the local authority to do that; there would be endless disputes as to what it should be, and it looks to me as if it is the business of the manufacturer to treat his trade effluent and what comes out of it.

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11167. (*Colonel Harding.*) In a large city to do what is suggested would probably lead to a demand that the local authority should cart away a multitude of matters produced in various trades, would it not?—Yes; that would be so, because there would be all sorts of things which the local authority would be called upon to cart away, I have no doubt. For instance, in the leather trade, or more especially in Leeds, I should think there would be more trouble in Leeds than anywhere in taking it away.

11168. (*Dr. Burn Russell.*) At present under Municipal Acts, even a baker's ashes—his clinkers—are carefully excepted. They do not deal with trade refuse at all in local Acts?—No, I do not think they do.

Mr. George Sheard, called; and Examined.

Mr. G. Sheard.

11169. (*Chairman.*) You are a woollen manufacturer, and a member of the firm of M. Sheard and Sons, Limited, woollen manufacturers, Batley?—Yes.

11170. May I ask you whether the water that you use in your business is taken from a stream or not?—For scouring purposes we get it from the town, pure; but for condensing purposes and boiler purposes we get it from the stream.

11171. You take that from the stream, but not the greater part of the water that you use?—Yes; the greater part comes from the stream.

11172. It does; and, therefore, of course, it has to go back to the stream?—It goes back to the stream, yes.

11173. Then what treatment do you give to the effluent from your works?—Our dyehouse we have closed, consequently we have no dye-water to treat. The scour effluent we treat chemically, and extract fatty matter as far as we can.

11174. (*Colonel Harding.*) In ordinary "seak" tanks?—Yes.

11175. By sulphuric acid?—Well, we virtually sell it; it simply goes across the road.

11176. It is treated there?—Yes.

11177. But the effluent from the tanks contains a great deal of grease still?—Not very much. They are getting it now fairly pure—at least, they are much better than they used to be; they are struggling more and more with it.

11178. (*Chairman.*) Then is some of your effluent not treated at all?—What we draw of the impure water from the beck, that we do not treat; it goes back as we get it.

11179. You draw impure water from the stream?—From the stream.

11180. You do not treat that in any way?—No.

11181. That goes back to the stream untreated?—Yes.

11182. Does all your effluent go into the stream?—Yes; altogether.

11183. None of it goes into the sewers?—No.

11184. Do you treat some of your effluent then because it is originally pure; is that the only reason why you treat it?—No; there is, of course, some small value in the scouring water, and that is the reason why it is treated. That has been treated for twenty years.

11185. You only do it because you find it of value?—We commenced to do it before this Act came into force.

11186. (*Colonel Harding.*) The object is the recovery of grease and not purification?—Yes.

11187. (*Chairman.*) It is only for your own objects you treat it at all?—We simply continue what was done before. It was originally for our own objects.

11188. Do you no longer consider that it is for your interest to purify it?—Well, it has got smaller and smaller. There is very little value in it at the present time.

11189. (*Colonel Harding.*) As a fact, Mr. Sheard, you sell it to somebody, who extracts the grease?—Yes, we do. The value of it at the present time is about 20 per cent. of what it has been at the highest point.

11190. (*Chairman.*) No question has arisen as between you and the local authorities?—None whatever.

11191. Then, of your own knowledge, you can say nothing about the position and rights of manufacturers and local authorities as to whether they are satisfactory or not?—I can say nothing with reference to the local authorities. I can say that the manufacturers themselves are all of one class, and they require the same rights. They would all have to be dealt with on the same lines, as I have stated in the answers I have given to the questions submitted to me. We occupy a somewhat unique position, as Colonel Harding knows. This beck is an exceedingly small stream, and on Monday morning, when it is coming down pure, the people at the head of the stream impound it until when it gets our length—we are the twenty-third, I think, on the stream—it is almost impossible to start work at the ordinary time. On the Monday morning it takes probably from eight to nine o'clock; I know it does with people below us, because each one is drawing from the beck when it is in the purest state as much as he can get, and, consequently, the stream becomes absolutely necessary to us. It is a small stream, and yet if we had not it we could not run; we could not work at all. There are only two ways of dealing with this thing. One is that each manufacturer should do his best to turn the water pure again into the stream, or that there should be an independent sewer for the manufacturers alone, so that each one can tap this and turn the water back again into the same sewer, and that it should be dealt with close to the Calder. We put this before the committee of the Rivers Board in Leeds, and we were at once floored with this—we were quite willing to admit when we were wrong—that we could not deal with flood-water under those circumstances. The water would be much too heavy for us, and, consequently, the foul water would get into the Calder along with the clean, or with the flood-water. Now, if it be possible to have a separate culvert, from which each manufacturer could draw and turn it back again into the same culvert, and carry it forward to the bank of the Calder, and treat the whole matter there, it could be dealt with in the quantity that there would be then. I think almost everybody would be ready to admit that so long as there is only one purification of the water in the stream it would be much more likely that water would go in a better state into the Calder than it would if there were seventy people who would be purifying, or trying to purify, it individually. I should be very much astonished if we did not find that, whatever we do, there will be a black spot somewhere, and that some impure water will get into the stream, although we all do our best to make it satisfy the Rivers Board.

(*Colonel Harding.*) Lord Iddesleigh will perhaps allow me to take up the investigation at this stage?

(*Chairman.*) Certainly.

11192. (*Colonel Harding.*) You say when the matter was brought before the Rivers Board you proposed then to deal with the whole stream, but that, as you have since found out, and as we suggested to you, is quite impracticable. Your suggestion now roughly amounts to this, does it not? You would have a sewer to take all the impure matter that is put in, but not to take the remainder of the stream. But I should be interested to know what is the relative volume of what is drawn from the stream for those manufacturing purposes to the volume of the stream. Would there be any stream left when you had withdrawn?—In summer, no; I do not think there would be any.

11193. Then it means this: that in summer you propose to deal with the whole stream as a sewer?—Virtually, yes.

11194. But when there is more than you require for your purpose it would be allowed to flow down continuously, and so you would eliminate the difficulty of dealing with the flood-water?—Yes.

11195. Well, that is the suggestion. Now, is that a practical suggestion, really? Have you consulted any engineer as to its practicability, or its cost?—No, I have not consulted any engineer. I laid this before the manufacturers in the district, because I did not want to come here to make a statement of my own with which they would all find fault. They are all of opinion that it would be better dealt with in that

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way, if the ways and means could be raised to do it; but we hold strongly that, as manufacturing premises are rated for sewage rates, and they really have nothing at all to do with it, that this provision should be made by the local authorities.

11196. What would be the volume that would have to be dealt with by the local authority under your suggestion?—I should think there would be a volume of from 2,000,000 gallons to 3,000,000 gallons.

11197. Per day?—Yes.

11198. You suggest that a culvert should be constructed to carry this?—Either a culvert or a large sewer.

11199. And that it should be treated wholesale, as the confluence with the Calder?—Yes.

11200. It is rather a big business, is it not?—Yes.

11201. It would be a very serious cost?—Yes.

11202. And, I gather, you do not propose that the manufacturers should share in the cost?—No.

11203. Is there the least probability or the local authorities taking up such a suggestion?—That I cannot say.

11204. Do you think it is likely?—You see our position is this. Supposing we had a perfect right to turn it into its existing sewers, if they were large enough—but they are not large enough—we dare not let it go, because riparian owners would certainly each one come upon the local authorities if they did any such thing.

11205. May I ask are you yourself a member of one of the local authorities?—No.

11206. But you must have a considerable acquaintance with the local authorities?—Yes.

11207. Do you think it is likely that they at their cost, without any contribution from the manufacturers, would undertake this great work?—I should not like to say.

11208. Of course, it would interest both Batley and Dewsbury and Birstall. They would be the three districts to join in the cost of this?—I really should not like to say.

11209. But, as you admit, there is a very large expense in connection with separate works?—That is if each manufacturer is going to purify the water from his own place, and where there are dye works it is necessary to have the two systems, that is, you would have to treat them separately. You could not turn the dye water in along with the seak water. Dr. Wilson said there were seventy people who have works on this stream. That alone is a very large cost, and I think it would eventually come to this, that if the local authorities were—I was going to say reasonable, but I won't use that word—if the local authorities were willing to take upon themselves a portion of the expense, and that a portion of it should be raised by the millowners, seeing that there would have to be a considerable outlay on the other plants, it is quite possible, because the local authorities are wrapped up in the prosperity of the place, and if we can get rid of this foul stream out of the district, surely they are entitled to be called upon to do something.

11210. Then you think the manufacturers not only should but would contribute?—Well, I speak for myself personally. I would do anything in reason to get rid of this beck as it stands at present.

11211. You said you thought the dye water should be kept separate from the wool washing waters. That would mean two conduits, would it not?—It would for each manufacturer who had his own dye works.

11212. There are many dye works all the way down the stream; therefore you would have to have two culverts—one for dye works and one for wool water?—No.

11213. You would deal with them together?—Yes, because when the fatty matter is taken out it is very little worse. I do not consider that any effluent that we ourselves turn into the stream, if it was clear of the acid, is any worse than what you get from cottage property. I do not think we leave any more fat in the water that we use for scouring purposes than you get from cottage property.

11214. Do you use that foul water for condensing purposes?—For condensing purposes, yes. I have a letter here—I do not know whether it would interest you or not. I wrote to the Horsfields, of Dewsbury, who are large boiler makers. I do not know whether you know them.

11215. Yes, very well?—I wrote and asked them three questions, and this is the answer we got:—

"Messrs. M. Sheard and Sons, Limited,
"Woollen Manufacturers, Batley.

"Dear Sirs,—In reply to your enquiry *re* Royal Commission in London on Trade Effluents in the Batley beck, we give you the following reply to your questions on 70 years' experience, viz.:—

"No. 1. Is the water which we draw at the present time from the foul beck more or less injurious to boilers than pure water taken from the town mains?

"To this we say no, except for grease, and whether this is from the engine or the beck we cannot say." —Well, of course, there is no grease from the engine or beck—very little:—

"No. 2. If each manufacturer on stream purifies the water which he uses, and, in the process, has to use acids, so that probably 30 to 40 people will be using it, would this be injurious to the boilers, and to what extent?"—His reply is:—

"Our opinion is that if the water is purified with acids this will be more injurious to the boilers than the water in its present state, as to what extent we cannot say. The effects of the acid (in quantity) on the plates is bound to be serious, without the water can be treated again and the acid taken out. We have taken boilers out which have been worked in your district for 30 years, and, on taking the flues out, and having them scaled thoroughly, have found the plates practically as good as new; in fact, the last three boilers we took out at your own mills had been at work between 20 and 30 years, and they were all resold to work again."

11216. It is interesting to know, from Messrs. Horsfields' experience, that the foul water may be used in boilers?—With less injury than pure water.

11217. You are assuming, Mr. Sheard, that the treatment of the trade effluents would involve, as a necessity, the turning out of acid effluent, but that does not in the least follow of necessity. If the effluent is acid it must be neutralised before it is turned into the stream?—That is another question which will be raised as to the cost which will be incurred for the whole of the people who are on the stream itself. That will be an additional thing. Then I ask again:—

"No. 3. Which would give the greatest incrustation? —The beck water might give the most incrustation, but this can be overcome by using soda in solution. We may say that in our case we put in two new boilers for our own place, and we used nothing but town's water, viz., Dunford, and in 17 years they have both had to be replaced. We had practically no scale, but the water had a serious effect on the plates, the area extending along both sides of the shell, flues, and the gusset stays, and now we are having to use lime in solution to form a deposit to help to extend the life of the new boilers.

"Yours faithfully,
"J. and J. Horsfield."

11218. Then, your argument amounts to this, that it is better not to purify effluents?—No; I do not say that. Do not misunderstand me. I said a minute since I was one who was prepared to do anything in reason that can possibly be done, because I should like to see the stream pure, but there is a simple comparison between the two here.

11219. It amounts to this: you must not, in purifying the trade effluents, do it in such a way as to turn out the effluent in an acid condition. That is all it amounts to?—Yes, virtually; but it also amounts to this: If we had a sufficient supply of pure water from the town—the town water is infinitely worse for the boiler than the beck water, as he says here, speaking of boilers which have lasted 30 years, and he says they had to take out their own boilers that had had nothing but pure water in them at the end of 17 years.

11220. Then your suggestion to the Commission for the Batley beck is a culvert which shall carry the whole body down to the confluence with the Calder, and be there treated?—If it can be brought into feasible shape.

11221. But that is the point; is that a feasible suggestion?—I think so.

11222. You really think it is?—I think so, and from your standpoint I think you will admit it is better than dealing with them separately.

11223. I agree with you it will be less costly, and probably more effective if dealt with wholesale in that way,

and if it could possibly be done might offer a solution of the question satisfactory to the Board. At the same time, I venture to doubt the practicability of it, because the cost of it would necessarily be most serious?—Well, I do not think it would be more serious than that each man should have to employ somebody to watch these tanks, in addition to the capital outlay for the tanks themselves.

11224. If you come to the Commission and say: "We, the manufacturers"—how many did you say, 70?—Dr. Wilson says 70.

11225. We, the manufacturers upon this foul stream, suggest that this course should be followed and are willing to bear the cost," I think the Commission would be impressed probably by the practicability of the suggestion; but if you come to us and suggest that the local authorities should do this thing at their expense, I am afraid it is not practicable?—To show you the difficulty of answering a question like that. I was invited the other day—the Rivers Board were calling a meeting I think in Wakefield?

11226. Yes?—And I was invited to attend that meeting, and I wrote, and said I could not give an affirmative answer that I could come, but I should be sorry if I could not. I do not know why a meeting was called for the Friday before Whitsuntide in a place like Yorkshire. Nobody will be at home. At all events, I said I could not answer affirmatively before I knew who were coming, because I said if I was going to be the only one from Batley I should decline to come, for the very simple reason that I desired to put this thing before the Batley manufacturers, and I called a meeting. We had people from Dewsbury; we had people from Birstall, and I was there from Batley; there was not another Batley person there. It is quite enough to knock the steam out of a fellow if nobody takes more interest in it than that, and consequently it would be a very difficult matter for me to say that all the people on that stream who would not come across the road to attend a meeting would be willing to pay their quota of all the costs that might be incurred in carrying that out. That is the difficulty I have.

11227. You cannot say that they would?—I cannot.

11228. But do you think that they would?—Yes; I think so, along with the local authorities, mind you. I think the local authorities ought to be called on first. I do think that.

11229. You think that the manufacturers ought to share the cost with the local authorities, and that the work should be done in that wholesale way?—I do most certainly; I do not know what rates are paid by the mills of Batley alone—I speak more particularly for Batley—but the probability is, it is 50 per cent. of the whole rateage, and if the manufacturers already pay 50 per cent. and do not use the sewage works, do not you think they ought not to be called upon to pay much for the other?

11230. Have you any alternative suggestion?—I have not.

11231. It would be possible, would it not, to extract the grease more thoroughly than is done by the people who do it for profit at the present moment?—I think it is being done now. I think so. I do not know whether you have seen the last scheme. We have got an effluent of our own.

11232. Is that Mr. Turner's?—That is Mr. Turner's, yes.

11233. At present, is it a practicable thing, do you think?—I think so.

11234. Is there any reason why it should not be adopted, for instance, at your own works?—My dear sir, we are the smallest sinners on the stream. The effluent that we turn in from the people who buy the "seak" water is not quite so clear as Turner's, but pretty well, and I promise you one thing, long before you get down the stream the effluents in our works shall be dealt with. You are quite right in beginning at the head of the stream, but you will not find us sinners long before you purify above us, and we are ver~ very small sinners at the present time.

11235. I should like to inform the Commission that the beck upon which Mr. Sheard's works are placed is one of the most difficult problems with which the Rivers Board has to deal. These works succeed each other, adjoin each other, all the way down the stream. Many of the works have very little spare land, and I am bound to say that the difficulties of the manufacturers there are very considerable. There are cases, doubtless, as with Mr. Sheard's works, where the individual manufacturer may treat his effluent without prohibitive cost, and with fair results. There are others where it is very much more difficult, and the suggestion that Mr. Sheard makes to the Commission that a joint scheme should be carried out might be worth consideration, if the scheme had been thoroughly thought out, and its cost estimated, and if it were ascertained that the parties on the stream were willing to see this work done.

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11236. (*Chairman.*) You would have to get the consent of every riparian owner to it, I suppose?—We should have to do that.

11237. Of what sort of length would this culvert that you suggest be?—It would be three miles, I should think; yes, quite that.

11238. It strikes me as an interesting suggestion?—(*Colonel Harding*). It is interesting, but the Rivers Board had something similar before them a long time since, and the cost which was then foreshadowed was so enormous that it seemed utterly improbable it would ever be undertaken, and now Mr. Sheard says it would be proposed to eliminate the storm waters, the flood waters, and he suggests as a practical man to us that it would now be reduced to such proportions as could be carried out, but he is speaking for himself.

(*Chairman.*) Yes.

11239. (*Colonel Harding.*) And my experience of Mr. Sheard is that he has been willing all along to do everything that is possible, but I do not know how far he can be considered as speaking for the other manufacturers on the stream, many of whom seem very unwilling to do anything at all?—I believe if the individual treatment is adopted that in time all would be willing to carry it out, but if the collective treatment is not too expensive it offers infinitely better security for the proper purification of the effluent; indeed, it means one single plant as against seventy.

11240. Do they all extract the fatty matter?—Nearly every one.

11241. As far as it is profitable to do so?—Yes; that expense which has already been incurred would not be thrown away.

11242. To judge whether your suggestion would be of value to the Commission it would be necessary to know that it had been investigated there, and that there had been a meeting of manufacturers on the beck, and that a willingness had been expressed by them to share with the local authorities the expense of such a scheme?—Had we not better await the result of your meeting on Friday week before we call one, seeing that when we called one before I was the whole meeting, so far as Batley itself was concerned, though there were a few from the same watershed. I see Mr. Oldroyd was asked. I saw his nephew when I was coming up the other night, and he said that Mr. Mark Oldroyd was asked to come, but he was away.

11243. It might be better to postpone that meeting?—Yes.

11244. We will consider that?—If anybody does take advantage of the two days at Whitsuntide for a holiday, they naturally go away on the Friday. Then there is another question in this which may be somewhat serious, and that is that each manufacturer, or nearly each one has a reservoir of his own. What are you going to do with the deposit? It must go down the same course. Take our own, for instance. You know the road that I went along with you, which is the turnpike between Dewsbury and Bradford. Well, our reservoirs go the full width of that road underneath. The town itself pays us an acknowledgment for letting them put the drain there, and underneath the road is our own freehold. We have no earthly place but that, and perhaps you will make it as easy as possible. We flag the bottom of our reservoir, so that when we clean it we may get it as liquid as possible, and let it go in the best form we can.

11245. Cannot that deposit be taken out and put upon the land?—I dare say we might manage to put it on the turnpike. It will all have to go out on the turnpike, as far as we are concerned.

11246. Surely there is other land than the turnpike?—There is no land. We go under the full width of the street—it is a 40 foot road, and we go under the full width of it.

11247. Well, cannot it be carted away further?—It wants to dry.

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11248. It can be dried ?—But how can you dry it when the whole of our reservoir is under the road ?

11249. You are not obliged to dry it in the reservoir ? —Not in the reservoir ; it must come out to dry.

11250. It can be pumped out to some place in which it can dry ?—I do not see where it could go, and that holds good with everybody. I do not know whether this thing can be dealt with by the reservoirs being cleaned periodically, and if it was arranged that not more than the settlement of a single reservoir should go down on any one day, and with due notice it was going down on that day. I think it might be dealt with in this way. It would not be so very very much if there was a fair flow of water.

11251. Lord Iddesleigh will understand from your answers how difficult the case of this beck is, where the manufactories touch each other all the way down, and there is so very little spare land. At the same time, given a willingness on the part of the manufacturers to incur some expense for the purpose of bringing about the purification of their effluents, it does not follow that something might not be done ?—Oh, I think something might be done, and if the question of expense with reference to dealing with the whole of it does not go down, if that was to put it out of court, there is no alternative but that each man should deal with his own. There is no other alternative at all, because it must go back into the beck ; we cannot possibly run without it. Last summer only a number of us had to save our scouring water ; there was no town water. Consequently we might want three times as much. You cannot get it from the town if you want it for condensing purposes, and we could not live without it. There is no single question at all about it. The works in our valley could not run without the water from this beck plus the water which we put in, and buy from the town and pump, so that whatever report you may have to make, it would be ruinous to the whole of our district if the riparian owners do not retain their rights.

11252. We may assume that to be so. Then the two alternatives are that the combined tanks of all these manufacturers should be treated at the bottom of the valley, and the other course, each one to treat his own ?—Yes.

11253. That is to some extent practicable, is it not ? —I think so.

11254. I mean for each to treat his own ?—There are one or two places—I asked Mr. Kershaw in your presence, when you were in Batley, if he would take you and point them out—places where they had not a yard of room.

11255. There are greater difficulties in some places than in others ?—There are two where they have not a single yard of land.

11256. In your district, knowing the district well, it would be practicable for many of them to deal with the effluent themselves ?—Yes, I do think so.

11257. And you know of means, Mr. Turner's and others, by which it could be done ?—Yes.

11258. Alongside of you is a bottle—will you look at that, Mr. Sheard—which has been shown us to-day by a witness who says that it is the effluent he is turning out by a similar process ?—A process similar to Turner's ?

11259. It is a process carried further. It is a process similar to Turner's, followed by filtration ?—Turner has filtration, not from the tank itself, but from the thick part of it.

11260. Do you agree, then, that it is practicable to purify these effluents from such manufactories as yours if you have space to do it on ?—Yes, I do.

11261. And within reasonable limitations of cost ? —Yes, I think so. To treat the seak water alone would probably cost £500, in addition to the other loss of the money that you get from the fatty matter.

11262. You recognise yourself, do not you, that manufacturers ought to incur some cost in doing this work ?—Yes, I do.

11263. (*Chairman.*) Then your suggestion on this culvert would be that the manufacturers would use nothing except the water that came into the culvert ? —Yes ; they would have the right still to tap the pure stream, not only to take water from the culvert, but also, if there was a good flow of pure water down the present course, they would have the right to take that.

11264. But in summer you would not expect there to be any water in the stream ?—There would be very little ; there is very little now in a dry season, next to nothing until we begin to pump.

11265. Then practically all you would have for use in the summer would be what was in the culvert, what came into the culvert ?—Yes. Of course you are aware that there are a great many people in other districts where they have a good supply of water who do turn in already, a great many people—hundreds of people, I believe—who do turn in, but that is where they have a good supply of water.

11266. Do you consider that the position and rights same right as the man who is already doing it at the at present fairly defined ?—No ; because some of the Batley people would tell us they are not bound to provide. In other places, where they have allowed a number to go into the main sewer, then I think it is an admitted fact that they must provide for everybody if they provide for any ; consequently, it is not sufficiently defined.

11267. Do you consider the law ought to be altered so as to give manufacturers greater rights than they have at present to connect with the sewers ?—I think so ; but it must always be so as not to interfere with the rights of the riparian owners. That must always be borne in mind.

11268. (*Colonel Harding.*) Certainly.—If every man was to turn into the sewers it would be ruinous to our district altogether. I do not think, perhaps, there are very many—Colonel Harding knows whether there are very many—situated as we are, but we are about as bad as we can be.

11269. (*Chairman.*) Would it be your opinion that all manufacturers should have a right to use the public sewers ?—Yes.

11270. It would ?—Yes.

11271. Well, then, do you consider there would be any safeguards required to secure the refuse being delivered in such condition and in such quantities as not to interfere with the purification of the sewage ? —Well, as to quantities, that is a very difficult matter again, because that would involve a considerable amount of space. We cannot turn it out in regular quantities, except by storing it as it comes from the works, storing it, and letting a certain quantity run right away through. That would be a very difficult matter again, because there would come in the difficulty of providing storage for the water ; and I think the local authorities, if they will only exercise the powers that they have—that is with reference to solids, things of that sort—have quite sufficient power. It is a thing we have never heard of for the last 15 years in our district. We used to. When I was a young man—I do not think there was a man on the stream that was not a sinner in that respect—we used to put in dye wood. That is a thing of the past, because dye-wood is almost unknown. You simply get it in liquid and that is done away with. When dye-wood is used largely, it is very often burnt ; afterwards we got to that point that we burnt it. But now there is no wood at all ; it is simply the extract of the wood that is used ; consequently there is no solid at all, and it flows off in the water.

11272. Now take the case of a manufacturer who wishes to turn his refuse into the public sewer. What do you think the local authority might fairly call upon him to do ; would they ask him to pay something for the privilege of doing so ?—Well, that is levying a tax on a number of people who do it already.

11273. I am not taking the case where the thing is established, but where a manufacturer wishes to do it ? —Why should not the man who asks for it have the same right as the man who is already doing it at the present time. Why should one be taxed and not the other ?

11274. You consider a man ought to have the right ? —He ought to have the right to go into the sewer.

11275. Even although the sewers have not been constructed with reference to his refuse ?—Yes.

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11276. Then suppose the sewers are not big enough to take the refuse?—Then it is the duty of the local authorities to provide them.

11277. Then would you say that the public authority ought to provide it without charging him anything?—Without charging him anything. He is charged to a very large extent. The interest of the sinking fund is paid already, probably to the extent, in a district like ours, of 50 per cent. If it is done by the town itself, if half the rates are paid for by the business premises, half the sinking fund would be paid. That is already a tax of half the cost, and I think that ought to be quite enough for any manufacturing people to be called upon to pay. You must not lose sight of that. If we were to go and say, "Well, we are quite prepared to meet you, and there will be a certain percentage, just for argument's sake, say 30 per cent., 40 per cent., or 50 per cent. of this expense that is to be increased by us. If it is 50 per cent. we are going to do it all practically, because it all comes back from us again very largely," and that is where I think that the town does derive considerable advantage from getting a stream of pure water; seeing that they get the advantage of that, I think they ought to take the expense upon themselves altogether. You may fairly say it would be a mortgage upon manufacturers' property to do this. If it was done by the town, they would have to repay it, but I think that the town ought to do the whole of it. But if it came to be a matter of negotiations, it would, perhaps, simplify the matter—as far as I am individually concerned, I think it would simplify the matter very largely—we take up the position that Colonel Harding, as Chairman of the Rivers Board, has taken up, that there should be one authority to deal with, and only one, so far as Batley, Dewsbury, and Birstall are concerned. If the effluent is not going into the culvert in the state they desire it should go in, they have no means of dealing with the people who are purifying at the other end. As it stands at present with 70, each one has his own style of doing it, or there may be a fairly uniform style of doing it, but if there is something foul gets into it, which of the 70 is it? That is the difficulty you will always have to contend with.

11278. Do you consider that the local authorities would have a right to say to the manufacturer you must clear your effluent of all solids?—Not suspended solids.

11279. Not suspended?—I think not. I think the sewage matter has more suspended solids than we should turn in. You might have a system which gives a fair length of time for settling, and get rid of the suspended solids as far as you can do that.

11280. (*Colonel Harding.*) You are making a difference as regards suspended solids. You think that light suspended solids should be allowed to pass, and that solids which are likely to settle and interfere with the bed of the stream ought to be kept out?—Yes; they ought to be kept out most certainly, and the other ought to be got rid of, as far as you can, with a fair plant.

11281. (*Chairman.*) Then you will admit that the local authority ought to be allowed to say to the manufacturer, "You must keep out certain of your solids"?—Yes; they have the power now. They could prosecute any man on the stream that put ashes in, or anything of that sort, even in flood time. In flood time, of course, they are taken away, and no doubt they land themselves in the Calder somewhere, but the local authorities have full power to prosecute any man who puts in solids of that character.

11282. Supposing a dispute were to take place between the local authority and the manufacturer, would you be in favour of there being a special tribunal?—Well, I should say no. I do not know what the tribunal would be; it would probably be the County Council. Well, on the principle that the tender mercies of the wicked are cruel, sometimes we do not want to put too much on the County Council. I would rather that we should get thoroughly established first, but if it is to our interest that this thing should be carried out, then I should say yes. I should not object to it for a minute, because that would be the final appeal. We do not want to go from one authority to another until you half ruin yourself in going to the House of Lords appealing about a thing of that sort. Nothing pleases me better than that circular I got the other day from the Rivers Board, because I think that is just where we ought to have begun, exactly.

11283. Are you able to say what are the reasons which are commonly advanced by the local authorities when they refuse to allow trade refuse to go into the sewers?—The only reason that could be advanced with just cause, is that their plant is not large enough. The sewer is not large enough; they could not take it.

11284. Then you would say they ought to make them large enough?—I do, for the reasons I have given, for the reasons that we are taxed for sewage, and we shall have to repay the outlay to a large extent, whenever it is repaid. That is, to my mind, a very strong reason, because there is no sewage goes from the mills beyond what would go from the house; consequently, the mill itself is not responsible for the sewage, but yet they pay the rates to the full extent.

11285. (*Colonel Harding.*) There are just two questions I should like to ask you, Mr. Sheard. First, with reference to the culvert suggesed, would it be possible for manufacturers to draw from the culvert foul water for their trade purposes, as well as for their boilers; for instance, for the washing of wools or the washing of pieces?—No; I do not think so, because it would be as foul as it is now.

11286. Then in those cases each manufacturer would have to draw from the stream the pure water, and then turn into the culvert the foul water?—Yes.

11287. So that there would be less and less water in the stream as you went along?—In summer I do not think there would be any water at all.

11288. Then how would the lower manufacturers do? There would be no water left. They would be drawing from an empty bed?—They would have the same quantity of foul water to draw from. It is all foul at the present time.

11289. Now they draw from the foul stream?—Not for washing purposes.

11290. They draw from an independent source of supply for washing purposes, do they?—They either pump it or get it from the town.

11291. So that when you said manufacturers might use the foul waters coming down the special sewer you mean that they would use them for condensing purposes, and for the boilers?—That is all.

11292. Not for trade purposes?—That is all.

11293. The other question I wanted to ask you is in regard to the appeal body. You were saying that the County Council, followed, it might be, by court of law, and finishing with the House of Lords, is a much too costly and lengthy process. Do you think a special body, if there was such a body, in London, dealing with the rivers of the country generally, would be a good body to appeal to on such matters?—I think so.

11294. (*Chairman.*) You think it would?—Oh, yes, I do think so, rather than the ordinary courts, and let us have the first case the final one.

11295. (*Colonel Harding.*) You would not like to give additional powers to the Rivers Boards?—Personally, I should not object at all, because I do think that the time is coming when we shall be at one with the Rivers Board. I do think so.

11296. I am glad to hear you say so. The manufacturers might say, "The rivers authority is the local rivers authority. We appeal from them to the central authority in London"?—Yes; they might have one appeal beyond. That would be perfectly satisfactory. I hope you will not forget what I have said with reference to riparian owners. That is a difficulty I know of in our district.

THIRTY-EIGHTH DAY.

Thursday, 8th May, 1902.

PRESENT:

The Right Hon. The Earl of IDDESLEIGH (*Chairman*).

Sir MICHAEL FOSTER, K.C.B., M.P., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B. R.E.
Mr. W. H. POWER, F.R.S.
Professor WILLIAM RAMSAY, F.R.S.
Colonel HARDING.
Dr. JAMES BURN RUSSELL.

Mr. F. J. WILLIS, *Secretary*.

Mr. W. E. Walker and Mr. Harvey.

8 May 1909.

Mr. W. E. WALKER and Mr. HARVEY, called; and Examined.

11297. (*Chairman.*) You are Mr. Walker, of Messrs. Walker and Son, Limited, tanners, of Bolton?—I am.

11298. May I ask whether you come as representing your own firm only, or as representing other firms?—We represent more than ourselves. We are members of the Manchester and Liverpool Tanners' Federation, and a hurried meeting was called of the tanners in the federation; it was not a very largely attended meeting, because the notice was very short, but probably some seven or eight firms would be represented at the meeting held that day. The federation represents 28 to 30 firms—the largest firms engaged in the leather industry in Lancashire. There is a similar federation in Leeds and another in Bristol. We represent the Lancashire one.

11299. Have you had any dealings with the Rivers Board?—Not directly. Personally, I have not. Of course, I have been affected by the Rivers Board, through the local Corporation. They bring pressure on the local Corporation, and, through the local Corporation, that pressure has been brought to bear on manufacturers, but, as we turn all our effluent into the town sewers, the Rivers Board has not dealt with us directly.

11300. And would you be able to express any opinion as to the value of the work that has been done by the Rivers Board?—Well, I could not say, from practical experience, what the value is, but I should think it must all be on the right side, inasmuch as much greater attention is being given now to the treatment of effluent than ever was given before.

11301. You would be well inclined to the Rivers Board?—Well, I have never had any dealings with them, so I do not know in what spirit they approach the different bodies that they have to deal with. My answer was a general one as to the general result of the efforts they have made.

11302. In some cases you take your water from the stream for the purpose of your manufacturing, and then, having taken it from the stream, it has to go back to the stream?—Yes.

11303. And in other cases the water is drawn, not from the stream at all, and there is no necessity for returning it to the stream. I suppose, if you speak for so many firms, there are probably firms who do not draw their water from the streams, and firms who do draw their water from the streams?—I think the majority of the firms we represent do not draw their water from the stream.

11304. They do not?—No. I do know one or two, and they are forced to put it back again, the same volume of water, but they are exceptional cases. The majority of firms that we are associated with either have wells of their own, or they use town water from the town mains.

11305. And the obligation to return it to the stream does not come in?—No.

11306. They all return it into the sewers?—Yes.

11307. Would you say that the positions and the rights of the manufacturers and the local authorities under the existing law are clearly defined?—No, I should not say so, because there is a great variety of opinion.

11308. You mean that the positions and rights are not understood generally?—I am pretty sure they are not. I hear of different local authorities holding different opinions, and taking different actions, and I know that the opinions held by manufacturers vary equally as much.

11309. Do you consider that the law ought to be altered, so as to give manufacturers greater rights than they possess at present to connect with sewers?—Well, I could not say, because we do not know what our rights are; they may be as much as we desire or they may not.

11310. (*Sir Michael Foster.*) Has your firm, or any of the firms which you represent, had difficulties with regard to connecting up with the sewers?—Well, to take my own case, we have been turning into the sewers for nearly 100 years; the Corporation, under pressure from the Rivers Board, threatened to disconnect us from the town sewers.

11311. On what grounds?—The difficulty they had in treating our effluent; they were advised by the town clerk that they had the power to do this. We disputed it, inasmuch as we claimed that we had put our effluent into the sewers for such a long space of time, that we were heavy ratepayers, and paid rates for the treatment of this effluent; they took further advice, and they were advised they had no right, and so they do not know where they are, and we do not know where we are, so the thing hangs fire.

11312. (*Professor Ramsay.*) Has the work grown very much during the last 100 years?—Yes, that is their strong point. They say if we have a claim, it only applies to a portion of our effluent. That only seems reasonable.

11313. (*Major-General Carey.*) Do you treat the effluent before you return it to the sewer?—We do not treat it, but we let it settle.

11314. In settling tanks?—Our position is this. We have told the Corporation we will do anything that is feasible and reasonable if they will only tell us what is feasible and reasonable. They do not know; they are very anxious to know, and they have taken considerable trouble to find out; but I do not think they are prepared to say yet what scheme they would like to adopt.

11315. (*Colonel Harding.*) But are they not prepared to say that you must settle the solids anyway?—Yes, but the tanners' effluent goes on making solids for days and weeks. It is constantly precipitating, and solids are formed.

11316. But if you pass your effluent through a settling tank, say, with a day's supply, surely a great proportion of the suspended solids will go down there?—Yes, that is the mode which most tanners adopt, of having one, or sometimes half a dozen large tanks, and keeping it undisturbed as many days as they can, and running it away in regular quantities, which, of course, is a great consideration to local bodies; they know how much to expect, and therefore how to adapt their treatment.

11317. Then you think it is quite practical, within reasonable limits of cost, to settle the grosser solids and to have an intermediate tank which will permit of a regular flow into the sewers?—I think that is the simplest and the best, but I do not call it a perfect system. I am afraid, to get at one more perfect would mean so much expense that manufacturers could not bear it.

11318. (*Major-General Carey.*) You mean by more perfect using chemical treatment?—I think so, yes.

11319. (*Chairman.*) What do you do yourself; do you have settling tanks?—Settling tanks; that is all we have.

11320. More than one, I mean; does the same effluent go through more than one tank?—No, it does not—well, yes, it does, in a way, but only one large tank. I do not think the others are worth considering. I do not think the local authorities would recognise them at all, so we had better leave them out of the question.

11321. (*Sir Michael Foster.*) And the outfall from the tank into the sewers is fairly regular?—No; it is not.

11322. (*Colonel Harding.*) It could be made so?—It could be made so, and it will be made so when we have agreed with the local authority on the means to adopt. I do not wish to infer that there is any friction between ourselves and the local authority; there is not; it is simply a question of not spending money on useless schemes.

11323. (*Sir Michael Foster.*) You are considering how you can do best for both parties?—Yes, we are considering. Many appliances have been inspected—have been inspected jointly by ourselves and representatives of the Corporation. We are working together in that matter, and the delay is just on that point; we want them to say what will be satisfactory to them, and they do not want to commit themselves to something which will not be satisfactory, of course.

11324. Meanwhile they are content with the present arrangement for the time being?—That is so; that is the position.

11325. (*Professor Ramsay.*) Do your tanks hold more than one day's supply?—No; they will not.

11326. (*Sir Michael Foster.*) Do you deal with all classes of hides?—No.

11327. Only certain classes?—Two classes, English and foreign hides, which are salted.

11328. Has anthrax ever got into your works?—No, never; that is mainly confined to China hides, I think, occasionally discovered in Bombay hides; but by foreign hides I mean mostly Continental hides, and I think the cases of anthrax are very, very occasional in these hides.

11329. (*Chairman.*) Therefore, for the moment you and the Corporation are at a sort of deadlock?—Yes, a friendly deadlock.

11330. But all your effluent is going into the sewers?—Our effluent is going into the sewers, and the Corporation are treating it and turning it into the River Irwell, and the board which controls the river object to the condition, the quality, of the Corporation effluent, and they are turning their attention on the bigger sinners at home, I suppose, and they fixed on ourselves as one of them.

11331. (*Sir Michael Foster.*) What methods are the Corporation employing for the purification of their sewage?—Land filtration.

11332. (*Chairman.*) Have they got a large sewage farm?—Yes.

11333. A large farm; it is Bolton Corporation?—Yes, Bolton Corporation; the sewage farm is between Bolton and Manchester; I should think about 150 acres.

11334. (*Sir Michael Foster.*) What distance from Bolton?—I should say about five miles, quite.

11335. Do you know the character of the soil at all?—Only by passing it on the railway line.

(*Sir Michael Foster.*) I mean, is it sandy or chalk?

(*Mr. Harvey.*) Gravel. I should say it was gravel.

(*Mr. Walker.*) It is not a heavy soil; at least, judging it from the railway train, which goes almost through the farm; you can form an estimate of the soil in passing.

11336. But the effluent which comes from the land is unsatisfactory?—It has been pronounced so by the Rivers Board.

11337. Is it coloured soil?—Yes; unfortunately, it is coloured brown, and, tan liquor being brown, hence the close connection. I think most things that are dirty are brown.

11338. (*Major-General Carey.*) The Bolton Corporation have expended large sums of money on their works within the last few years?—Yes, they have; and they are still incomplete.

11339. (*Chairman.*) Would there be a great amount of tannery refuse in that Bolton sewage?—No; we are the only works in Bolton.

11340. The only tannery?—The only tannery.

11341. Then the brown colour of their effluent from their farm can hardly be due to you, I suppose?—Well, tan liquor being as valuable and as expensive as beer, it is not very likely that we should run very much away; but we do run some away.

11342. (*Colonel Harding.*) What is the volume?—I could not tell you, sir. I do not think that intentionally we run more than 5,000 gallons a week away of tan liquor.

11343. (*Major-General Carey.*) What is the total volume you put into the sewers?—That I have no idea of; I could not tell you; we have a great deal of water which is used in cleaning the leather, which carries away with it the loose tan which is not fixed in the hide; in making leather there is a certain amount of tan which unites with the hide, gelatine, and a certain amount of tan lying loose in the pores of a hide. That is washed out, and that, of course, is making our brown-coloured water, which they would call the tan liquor, and that is running into the sewer the whole day through.

11344. (*Colonel Harding.*) Then the volume of that is much greater?—Yes; I do not know how much.

11345. Then the total volume flowing from your works would be quite considerable?—Yes.

(*Colonel Harding.*) 50,000 gallons a day or week; have you any idea?

11346. (*Chairman.*) Have the Corporation, besides objecting to your effluent going into the sewers, objected to any other manufacturers' effluent?—The dyers; I think they have taken action against the dyers.

11347. And that is now in the same condition as yours?—Well, I think the dyers have done a little bit more than the tanners have, judging from the trade locally.

11348. Do you mean they have done more to meet the Corporation?—Well, dyers are principally on the streams; they use so much water that they do not use the Corporation water, and they use the water on the streams. They have water rights; most of the firms say that they have to put the water back, so they have to take considerable trouble.

11349. So they do not put it into the sewers, then?—No; I do not think so.

11350. Then it is only with you that a question about the sewers arises?—I should be inclined to say yes, but I cannot be quite certain that that would be a correct answer. I do not know of any other firm.

11351. But as far as you know?—Yes.

11352. (*Sir Michael Foster.*) You said one or two firms you represent took their water from the stream, and therefore had to return their refuse back into the stream?—I do not represent those firms directly, but I know of one firm. I was only speaking to a tanner in Leeds—in fact, he is the largest tanner in Leeds, Mr. Harold Nickols, and at one of his tanneries, the Meanwood Road Tannery, he draws water from a stream, and he has to put it back again.

11353. Yes; we have had evidence about the Meanwood?—Yes.

11354. I thought you said one or two firms of the association that you represented?—Not that I know of. It is possible, but I do not know all the circumstances.

11355. (*Chairman.*) Well, then, I understand that you would be willing—in fact, you are trying—to meet the reasonable demands of the local authorities?—I should think that that is the general feeling throughout the trade; I think that every manufacturer recognises that he has not an absolute right to turn any muck he likes into the sewers, but, naturally, manufacturers hesitate to lay out capital in plant for treating effluent to be told by a local authority two or three years afterwards that it is inadequate, and that he must replace it. That is too great a tax on industry. If the local authorities would say what scheme would satisfy them,

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then the position would be solved at once. I should like to say here that the question of treating effluent by settlement, we have three yards in Bolton; in one yard right in the centre of the town we so built round, that we have no tanks, and we have nothing except little tanks about the size of this table, about three or four feet deep. The drain runs and runs out about four feet from the ground, so that in you have only four feet—a little well-hole the size of this table, four feet deep, to collect the sludge; and when you think that the stream is constantly running in and running out at the other end, the whole thing is in a state of unrest, so that hardly any settlement can take place. The very heavy solids will fall to the ground, and those are cleaned out every night at the request of the Corporation. They are willing to do that themselves.

11356. (*Sir Michael Foster.*) What is the nature of those heavy solids in your refuse?—The tan liquor forms a deposit, it adheres to the leather on both sides, and that has to be taken off. We call it "bloom"; that is the technical term for it, but it is a precipitant, and that falls and adheres to the leather.

11357. And that is sufficiently heavy to fall down, even in these small tanks?—Not all of it.

11358. But some of it?—Some of it.

11359. You spoke of the heavier parts?—Yes.

11360. As if some of the refuse were heavier and denser than the other parts, but it is really only, I suppose, a certain proportion of the precipitate?—A certain proportion; the heavier proportion.

11361. The large mass that coheres together more?—Yes, that is it. It would all settle in a day if it could be allowed to be still.

11362. (*Professor Ramsay.*) Do you know if experiments for the purification of tan liquor have succeeded, or the reverse?—Filtration through cinders; I have not seen it in England. I saw a yard about a fortnight ago near Hamburg, and they were trying an experiment there, filtering through broken bricks, but they were just constructing it, they had not it finished, so that with what success they are meeting I do not know; but they are on the stream, they draw the water from the stream, and they have to put it back, and the local authority is particular as to the character, of course, of the water they had to put back into the stream.

11363. (*Chairman.*) Do you think that it would be desirable to have a tribunal to whom an appeal could be made if the local authority and the manufacturers differed?—I think it would be absolutely necessary.

11364. And would you wish it to be a local tribunal?—No.

11365. Not local?—I think not.

11366. Any kind of Government body, say in London?—Yes.

11367. That is what you would like to see?—Yes. The Government inquiries that have been held have not produced any good results. The Commissioners that have been sent down have been very reluctant to decide between corporations and local manufacturers, as if they were in doubt as to the law on the matter. We have had one or two cases where I think the Local Government Board—I am not quite sure as to that, but gentlemen have come down to hold an inquiry on the spot, but it has never resulted in any satisfactory conclusion. They have simply advised that some friendly arrangement should be made, which does not really advance the question very much.

11368. (*Major-General Carey.*) To hold an inquiry about what—whether you remain discharging your effluent into the sewers, or taking it out, or what?—I am referring now to a case of Mr. Long, of Grappen Hall, near Warrington, who had some trouble with the local authority—an urban district authority. I think they engaged Sir Henry Roscoe to advise them, and the thing went on for a long time, and at last it was referred, I think, to the Local Government Board—I am not quite sure as to that—and a gentleman was sent down and he simply advised that the two should try and meet one another, and settle it in that way.

11369. Have the Corporation ever required you to take your tannery effluent out of the sewers?—No, sir. They did write to us to say that if we did not improve the effluent they would disconnect our drains from their sewers. We replied that they had no right to do anything of the kind. We claimed a right to turn our effluent into the sewers, because we had done for nearly 100 years, and that we paid heavy rates every year, and they accepted those rates for the treatment of our sewage and for other things. They took further advice, and we were told (so I understand) that they had taken up a position which was not a sound one, that it might be difficult to uphold, and they retreated from it. The cases that have come into the law courts that have affected tanners have all been cases where the tanners have turned their effluents into streams, so that it really does not give much information to these tanners who turn their effluents into sewers. Sir Henry Roscoe, who was engaged by the county authority in connection with the Cox case (Cox, I think, of Shrewsbury), said that the effluent was not fit to go into a stream, but it ought to have been turned into a town sewer. Well, when I read that, I thought that a town sewer was a proper place for a tanner's effluent, but we are advancing now. We find that four or five years afterwards the town authorities do not think that tanners' effluent is a proper effluent to go into a town sewer.

11370. When you say you do not think it a proper effluent to go into a sewer, do you mean because of the quality or because of the quantity?—I have not heard any complaint against the quality, except that it is difficult to clarify; it is not an unhealthy effluent.

11371. Then the objection is that there is too much of it?—I should think the great objection is that it is very difficult to get rid of the brown liquor, that it comes in uncertain quantities, and that when the double effluent—a tanner has two processes, the lime process, for removing the hair from the hide, and afterwards the tanning process. Well, the two, of course, run into the same drain, and one precipitates the other.

11372. (*Colonel Harding.*) Then probably the difficulty which arises is from sedimentation in the sewer itself?—Yes; lime and tan liquor precipitate one another and precipitate at once, but I have known by experience that the precipitation goes on for days, so that there must be a considerable sediment formed in the sewers, even after we have collected a great amount in the settling tanks.

11373. Your effluent is highly putrescible, is it not?—I should think that water from the soak pits—the pits into which the hides are put as they are received from the butcher, with blood attached to them, and dung in the winter time, is an objectionable effluent.

11374. We have heard—I do not know whether you have—of objection arising from putting tanners' effluent into the sewers, because putrefaction takes place in the sewers themselves, and very bad stinks arise from the ventilators in the streets. Might that be the objection made by the local authority to receiving your effluent. You do not know?—Well, I was hesitating, because the effluent from tanneries varies very much. There is a process called "baiting," which is used for all lighter leathers—leathers used for upholstering, such as this description, which is really a putrefying process itself. The hide is reduced by putrefaction. Well, that is an objectionable effluent, and those tanneries that have that effluent of course, have a difficulty, I dare say, in treating it, in order to put it into the stream.

11375. But, speaking generally, your effluent is not acid, is it, or alkaline? It is neutral, and it contains organic matter?—Yes.

11376. Which is generally of the same character as domestic sewage, is it not?—Tan liquor itself is acid when we draw it away.

11377. Tan liquor is mixed with other matters?—When we draw it away.

11378. Have you any experience whether your effluent is neutral or acid?—Our effluent will be alkaline, I should think, because the greater volume will be lime water. There is a great deal of organic matter in it.

11379. (*Sir Michael Foster.*) I suppose there are quantities of hair; what becomes of it—you say you are removing the hair with lime?—The process of liming, sir, is to expand the hide—to swell it to such an extent that the hair is easily removed with a blunt knife. The hair is not supposed to come off in the pit—I do not say that it never does.

11380. In summer time, I suppose, when the process is accelerated by the warmth of the weather, probably some small portions of it may come off the hide in drawing it out of the pit, and they may go down the drain, but it is not a difficult thing to collect the hair; we have a very small wire sieve.

11381. And you do that?—Yes; we have two, and the

drains are intercepted in two places, and the wire sieves are inserted.

11382. (*Professor Ramsay.*) What is done with the hair; is it burned?—No, sir, it is turned into blankets.

11383. (*Sir Michael Foster.*) But the tan liquor itself, I mean, is more or less antiseptic. It is opposed to putrefaction more or less?—It is antiseptic.

11384. More or less?—Yes.

11385. But the relative quantity to the rest of the effluent is so small, I suppose that the total effluent is putrescible?—Yes, I should think that in the tan liquor that runs away from a tannery the antiseptic property is very much reduced, because it is the oldest liquor in the yard, and it comes into contact with the hides in the first instance when they are charged with lime.

11386. (*Professor Ramsay.*) Is the bichrome process at all used in your district?—I think at Manchester they have it.

11387. You do not use it?—No, we do not use it.

11388. There is no question of the refuse from bichrome going into the sewers?—In the yard where they use bichromate of potash, I suppose you refer to.

11389. Yes?—I should think that would get into the effluent in any tannery where they have the chrome tannage, but at present there are very few tanneries in Lancashire and very small ones that are doing it. It requires a very small plant, and as a rule it is done by men who probably have room in their yard for a few tanks, or they are doing it in a cellar or something of that kind.

11390. (*Chairman.*) I think we have pretty well gathered your views as to the question whether manufacturers should be required to pay a special rate or charge to connect with the sewers. I suppose you would say there was no general rule about that?—Well, I should not like to speak as representing the Federation, because I have no mandate from them. I think their answer was, no, certainly not, or something of that kind. But I have thought about this matter since you wrote, and I certainly would rather pay an increased rate to the Bolton Corporation than dabble in any scheme at present, because I do not think at present we have sufficient knowledge to say what scheme ought to be put down for the tannery effluent, and I should think if it were put down now, in five years hence opinion would have grown and changed so much that it would be out of date, or probably so. I would rather make an arrangement of that kind, and we have suggested it to the local authority; it is under consideration; they move slowly. There is also another strong reason why manufactures situated in towns should not be compelled to treat their effluents—they would have to deal with a large amount of solid matter in a slushy state, which would require a large open space to dry it; then it would want carting away probably a considerable distance, as suitable places to get rid of such material are very difficult to find. Corporations and local authorities have plant already in existence for dealing with these solids.

11391. Then, what are the difficulties, should you say, that the manufacturers usually meet with in dealing with local authorities, and the reasons that are generally advanced by the local authorities for refusing to allow trade refuse to enter the sewers?—I think, in answering that question, I should say that local authorities were very often represented by committees and sub-committees. Take our Corporation. This matter is under the Sanitary Committee, composed of specialists, doctors, and others, but I do not think they are practical men. They profess to a certain expert knowledge of what is good for the health of the community, but they are not sympathetic in their attitude towards trade; they look at the matter entirely from one standpoint, and, if a manufacturer's effluent is not absolutely satisfactory, they would immediately cut him off from the sewers, whether it closed his place or not. That is one difficulty we have to meet, that we are dealing with a committee who do not understand the question they are dealing with. They rely on the borough surveyor or the borough engineer for their expert knowledge; they rely on the town clerk for their legal knowledge; and both of these gentlemen often lead them astray. That is our difficulty, I think, in dealing with the local authority, and, of course, the general difficulty (and you cannot blame them for this) that they do not know their legal position, and what rights they have as a corporation, and what rights manufacturers have as manufactures and as ratepayers. Their objections to our sewage are the difficulty they have of treating it with the chemicals they use for the treatment of the other town effluent; it requires different treatment; they never know when it is coming, they adapt their treatment to the ordinary requirements, when suddenly they are confronted with tanneries' effluent, which upsets their arrangements and their calculations, and is highly inconvenient. They also have objected to our effluent because of its colour, and I think that is because the Irwell and Mersey River Pollution Board has objected to the colour of the Bolton effluent which they turn into the River Irwell.

11392. (*Sir Michael Foster.*) You are not convinced that the colour of their effluent from the sewage farm is due to the colouring matter in your effluent?—No; I do not think there is sufficient tan liquor goes down our effluent to affect the colours of such a large volume as must come from a town of 150,000 inhabitants; it must be infinitesimal. On the other hand, lime water and tan liquor together make a very dirty brown combination.

11393. (*Major-General Carey.*) I suppose the Corporation are continually making analyses of their effluent, are they not—they know perfectly what it consists of?—Of the effluent as it comes to them?

11394. No, going from them into the river?—Yes; they know exactly what they are turning in, and the Rivers Pollution Board know too; they are constantly analysing.

11395. They know, or they ought to know, what the effect of the tan is upon the sewage in the effluent?—I do not know that they do, sir; would not that be very difficult to ascertain?

11396. (*Sir Michael Foster.*) Your position is, is it not, that there is no proof at present that the colouring matter, which makes the effluent from the sewage farm brown, is the same colouring matter as that which you are putting into the sewer?—I do not think there is, sir. I should be quite willing to be convinced, but they have never tried to convince me. The fact that the two things are of the same colour is quite sufficient for the local committee.

11397. (*Chairman.*) Are there a great many different trades in Bolton? Is there any prevailing trade in Bolton?—Cotton.

11398. Cotton?—Yes; cotton is the staple industry; cotton, coal, iron, fourthly, leather.

11399. Then, when the local authority objected to your effluent going into the sewers, did they make any suggestion to you of what they proposed should be done?—No; they did not make any suggestion. We asked them to make a suggestion, and we invited them to prepare a scheme, that their own engineer should prepare a scheme, and we suggested to him that he should visit, with us, several tanneries, where we knew means were taken to treat the effluent before it was turned into the streams. I should think we have been to half a dozen different yards together—the chairman of the committee, the local engineer, and myself, and they cannot trust themselves to be perfectly satisfied with the conditions which the Leeds Corporation had laid down for the tanners in Leeds. A series of experiments, I think, were made some years ago at the Right Hon. W. L. Jackson's tannery in Leeds, at the expense of the Tanners' Federation and the Corporation jointly, and a system was adopted which the Corporation pronounced satisfactory. The Bolton engineer said he was satisfied with that, and that he would recommend the Bolton Corporation to adopt that system. Unfortunately, that was very near November, when the Town Council was re-elected. The committee was re-appointed with very few members of the old committee on it again, and a new committee now has the matter in hand, who do not know the past history, and they have not taken the matter up again. That is one drawback. Of course, in dealing with local authorities, the committees are constantly changing.

11400. There is no reason to suppose that they would not be satisfied with the adoption of the Leeds system, is there?—I think they would.

11401. You think they would be satisfied?—I think they would; but do you not think it is reasonable that a manufacturer should ask a Corporation for a guarantee that they will be satisfied with a certain scheme before money is spent?

11402. Are you prepared to adapt your works to the Leeds standard if the local authority guaranteed that they would be satisfied with it?—Quite, where the room allows, where we have land space to do it. It is simply a question of land space for settling tanks.

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11403. And then you would consider that it was reasonable, on the part of the local authority, to ask you to do that?—Oh, quite. I think our local authority has been absolutely reasonable since they withdrew from their first position, which was that they would disconnect our drains. Since then the arrangements have been perfectly satisfactory and agreeable to both sides, I think. We are simply waiting now for the Corporation to put before us a scheme.

11404. The expense of adapting your works to the Leeds standard would fall on you, would it not?—I put that question to the local authority in this way: that if they would put before us a scheme which was reasonable and feasible, and not too costly, that we had room to adopt, and they would say that that scheme was satisfactory to them, then we would adopt it at our own cost; but if they insisted on our doing something, and would not say it was satisfactory, then I thought the cost ought to be borne equally by the Corporation and ourselves, because then it is an experimental matter entirely. To that, we got no reply.

11405. And that is how the matter stands now?—That is how it stands now. I think that they will put a scheme before us, and that probably we shall agree upon something which will satisfy us both. I think so, but I do not think that all tanneries are as favourably situated as we happen to be.

11406. You mean they may not have the same facilities for meeting the requirements of the local authority?—No. I do not think that all townships, smaller townships at any rate, have the same facilities that Bolton has for dealing with its effluent. Bolton has spent an enormous amount of money lately. It has put about 4d. in the £ upon the rates to deal with its sewage, and I should think it is in a very favourable position compared with many towns.

11407. Do they treat the sewage before it gets on to their farm?—They do. Within a quarter of a mile, or half a mile, of one of our tanneries they have the sewage works, where they treat the effluent with chemicals, and at one time they thought of putting a separate sewer from one of our works to this place in order to get it absolutely free from tan effluent.

11408. (*Sir Michael Foster.*) Why did they give up that idea?—Because we are on one side of the railway and they are on the other, and it meant syphoning it under the railway, and you cannot get the railway to consent to those things unless you give them some *quid pro quo*, some favour back again; and I do not think the time is ripe for that. It seems to me that the tanners that are on streams are entirely differently situated from the tanners that turn their effluent into sewers—that the same law cannot apply to both. I think it is recognised that manufacturers who draw water from streams, or who turn their effluent into streams, ought to turn it in in a very good condition; because, probably, other manufacturers lower down the streams are using that stream for manufacturing purposes; and, again, they pay no rates; whereas a manufacturer in a town is paying—we are paying, I suppose, between 6s. and 7s. in the £ at Bolton; the rates are very heavy, and we claim that for that payment we have a right to expect something from the Corporation.

11409. I gather that you feel one great difficulty is that the proper way of treating your effluent has not yet been thoroughly thrashed out?—I think that is it, sir.

11410. That, of course, in any case, you would expect attempts made should not be so costly as to interfere with your business; but beyond that there is the great difficulty—a plan is not presented to you which you are assured would be adequately successful, so that it would be always maintained?—That represents my opinion, sir.

11411. (*Colonel Harding.*) Just one question. You represent not only your own firm, but an association of tanners?—Yes.

11412. How many members are there in your association?—Twenty-eight, I think.

11413. And are they all the tanners in Lancashire, or the tanners in a smaller district?—It is called the "Manchester, Liverpool, and District Tanners' Federation," and I think we go outside Lancashire; but mainly, I should think, probably 25 or 26 out of 28 are tanners in Lancashire, and they comprise the largest tanners in Lancashire.

11414. Evidently it is an important association?—It is young, but it considers itself very important.

11415. Then you just answered Sir Michael Foster that you are unable to suggest to the Commission in what way tanning effluents going into streams might be dealt with. Does your association recognise as one of its responsibilities the duty of finding out the best way of treating tannery effluents in those cases? Does your association consider it necessary, or is likely shortly to consider it necessary, to engage an expert, and to carry out experiments with a view to—what shall I say—working out your own salvation, rather than expecting that this shall be told you by some local authority or Rivers Board?—This federation was started partly with that idea. We felt that the sewage question would be one of the difficult questions which the trade would have to solve; and it was felt that individual tanners ought not to have to fight this battle themselves; and really, of course, when a tanner goes to the expense of putting down a plant, and proving whether it is successful or not, he is doing work for the trade generally.

11416. Then do you not think it would be a very good thing for your association to undertake this experimental work?—Well, there comes in the difficulty that different authorities have different ideas.

11417. Well, that is simply because of the uncertain condition of the question. Your association might throw a great deal of light on it in the general interest of the tanners in your district?—I think the federation would be quite willing to consider that. That was really one of the principal reasons why the federation was formed.

11418. How long has the federation existed?—About two years.

11419. And nothing has been done yet?—Yes, a great deal has been done, but not on those lines.

11420. I am glad to hear you say that the association was formed partly for this purpose, and that you recognise that that is a right thing to do. I earnestly hope that the association will take the matter in hand, and so help not only the tanners, but the local authorities?—The federation have their own chemist; but his work has been entirely devoted to questions which have come up in manufacturing.

11421. Remunerative work?—Yes. The federation is hardly financially strong enough yet to employ a man on research work alone. We have to allow him to take work, of course, and charge for it; we cannot keep him entirely; we hope to do so as we grow. I think you know that if the system adopted by the Leeds tanners was generally accepted by the local authorities that to a great extent would solve the greatest difficulty.

11422. But that is relatively a small matter, because the real difficulty arises where tanning effluent must go to the stream; that is where the difficulty of treatment arises. Where it comes into the sewers it is relatively simple; it is merely a question of settlement and intervals to cause a regular flow. It is the other question, I think, that your association might most usefully take in hand.

11423. (*Dr. Burn Russell.*) What you call your effluent is the total discharge from your works as it leaves them?—I am sorry I have come without the figures. It is two or three years since I had the figures before me, and I do not wish to mention a figure now which would be wrong; but if the Commission would like to have the figures I could send them. We got them out at the request of the local corporation. It is perhaps some four or five years ago; I could let you have the figures.*

11424. (*Chairman.*) Thank you, we would like to have them?—I might state them wrongly if I attempted to give them now.

11425. (*Dr. Burn Russell.*) I do not mean the quantity simply, but what you have been speaking of, and what the local authority referred to in their communications to you is the total discharge from your works from all sources?—I am not quite sure that I quite understand the question.

11426. Is it a composite effluent?—Yes; all our effluents go into one sewer; they are all mixed together.

* Mr. Walker wrote later as follows:—"I have gone carefully into the figures, and am of opinion that three million gallons per annum would be an outside figure."

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11427. They go into one discharge pipe from your work and from that into the sewer?—They do. Well, if it is not one discharge pipe, there are probably many; but they all go into one sewer from one yard, of course.

11428. Then how would you classify those elements in your effluent—from what sources?—The main source is undoubtedly from the lime yard. That would be lime water mixed with a certain amount of animal matter which is more or less putrescible; rather more than less, I should say.

11429. Then you have the tan liquor—that is separate, is it not?—There is not very much tan liquor turned into the sewer—not directly. In the summer time, when tan liquor is apt to ferment, more tan liquor is run away than in the winter time. I know many large tanners who do not run a drop of tan liquor away; they work it round, constantly re-strengthening it. Whether that is a good principle or not I do not know. It is not the universal custom. As a rule one's liquors get worked down through the yard until they are almost exhausted. They are acid then, and they are used to neutralise the lime which is brought in by the hides. Instead of using a lactic acid or acetic, they use the acid which is formed naturally in the weak tan liquor. Then they consider that the best thing is to run it down the drain; but I do not think you would find above a quarter to a half per cent. of tannin strength in that liquor; but it is brown. To a man who did not understand anything about the trade he might think it was strong liquor, but it is not; it is brown in colour, because the tan and the lime form rather a brown colour.

11430. That is after the lime joins the tan?—That is after the lime joins the tan.

11431. But before that period?—Before that it is a very thin brownish yellow liquor—almost exhausted.

11432. Then would it assist your difficulties to deal with that small portion of tan liquor alone instead of dealing with it in the mass of your total discharge?—We could only take out the solids, could we? I do not know what means could be employed to decolourise it—whether it would be possible or not. I have never tried any experiments on those lines.

11433. What I mean is that it would be surely more easy to deal with the colouring element by dealing with the ingredient in your sewage that produces the colouring matter than after it has joined the mass of the discharge from your works?—I see your point, sir. You think it would be better perhaps to have two separate drains and two separate sets of settling tanks; one for your lime yard and one for your tannery.

11434. I am not giving you any opinion at all; but I am looking to you as thoroughly understanding the various elements of your sewage, and how they bear upon the ultimate problem, and therefore expecting you to give some indication of how to attack the problem?—Well, if you follow it a little further than that, you would settle the solids out of the two different materials—the two different effluents; they would eventually be joined together in the town sewers, and the precipitation would take place there; and I should think it would be better for the tanner to precipitate by mixing the lime and the tan together in his settling tanks rather than to allow the precipitation to take place in the town sewers. I may be wrong in that; it is just an idea.

11435. Then what do you do with your rainfall?—We use it.

11436. Is there no surface water allowed to join the mass of your discharge?—Oh, yes; you cannot help some. Of course, what falls on the roadway runs down the drain, but what comes from the roofs of the buildings we run into the tank from which we draw the water for the boiler.

11437. (*Chairman.*) We are extremely obliged to you for your evidence, which has been very interesting?—I shall be very glad if I can help in any way to solve the question.

Mr. John Stanning, Mr. Ross Gemmell, and Mr. Alfred John King, called; and Examined.

Mr. J. Stanning, Mr. R. Gemmell, and Mr. A. J. King.

11438. (*Chairman.*) You represent the Calico Printers' Association, Limited, and Bleachers' Association, Limited?—(*Mr. Stanning.*) We do.

11439. I will just ask you this general question first. Manufacturers have to be divided into those who draw water from streams for their works and have to return it to streams, and manufacturers who draw their water not from streams, and who, therefore, need not return it; do you represent both classes?—If you allow me to say so, I do not think you can draw a distinction of that sort.

11440. Well, there is a distinction in this way, that the water that is drawn from a stream must be returned to a stream?—Certainly.

11441. In the case of manufacturers who do not draw water from streams, they are not obliged to return it?—Not to the streams.

11442. No?—No.

11443. Well, do you represent manufacturers who draw their water from streams and manufacturers who do not do so; do you represent both classes?—Both; there are manufacturers who do both—both use water from streams and also from springs—both.

11444. (*Sir Michael Foster.*) But those who take the water from the stream must return it to the stream?—Certainly; I believe that is the law.

11445. (*Chairman.*) But you represent manufacturers who do both the one and the other?—Certainly, there are plenty who do both. As Mr. King points out, also there are plenty of bleachers and dyers who take Corporation water for dyeing or bleaching from the Corporation.

11446. (*Sir Michael Foster.*) There is a considerable proportion, then, of your Association that takes water from the stream?—Oh, mainly. (*Mr. Ross Gemmell.*) The bulk of it. (*Mr. Stanning.*) The bulk of it.

11447. (*Chairman.*) Well, may I ask you your opinion as to the question whether the position and rights of manufacturers and local authorities under the existing law are pretty clearly defined?—We do not think they are.

11448. You think that the law should be altered so as to give manufacturers greater rights than at present to connect with the sewers?—Yes, we do. I think we have sent a written reply to that question which expresses our views.

11449. We should like to hear it, because it gets on to the evidence?—Then, may I read the reply?

11450. Certainly?—"We are uncertain what rights manufacturers now have, but we think a distinction must be made between towns and other smaller authorities. (a) In towns it is practically impossible for manufacturers to purify their effluents in the same way as might be done in the country, where space is available. We think, therefore, that in towns manufacturers, or at any rate old-established manufacturers, should have the right to turn all their effluent into the sewers, subject to the safeguards and terms mentioned below. (b) In other districts the local authority might be unable to deal with a large volume of water, but manufacturers should, subject to the safeguards mentioned below, be allowed to turn a portion of their effluent into the sewers. In the case of calico printers or bleachers the worst of the effluent, if separated from the other waters, might be turned into the sewers without overtaxing the local authority, though in the case of small authorities the volume must be limited." I can, if you wish, give you a case in point.

11451. Yes, we should like to hear that?—Well, it is my own case. I am in a country district with a population of about 7,000 people. Their sewage effluent will be perhaps 150,000 gallons a day. The effluent from my works is 800,000 gallons a day. Now, it seems to be almost absurd to ask the local authority, which, in the ordinary course of things, would only deal with 150,000 gallons a day, to go and deal with 800,000 gallons a day.

11452. (*Professor Ramsay.*) In addition?—In addition. That seems an impossible thing to demand from anyone

11453. (*Sir Michael Foster.*) Might I ask what is the character of your refuse?—It is the ordinary bleacher's effluent. The pollution is caused by the size that we wash out of the cloth, not by anything that we put into the cloth, but the size that we wash out of it, that is the main cause of the bleacher's pollution.

11454. It is found rather difficult to deal with generally, is it not?—The size?

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11455. Yes?—It is difficult to deal with.

11456. (*Colonel Harding.*) Do you deal with it?—We try; I cannot say that we have been altogether successful, but we have done a great deal.

11457. What do you do?—Precipitate and settle.

11458. With chemicals?—We use a little alumino ferric, precipitate with that, and settle; we have large settling tanks.

11459. With what results?—They are only fair results. We are making further experiments in the way of dealing with it, which I hope may be successful, but it is a little premature to talk about it.

11460. (*Chairman.*) And where does your 800,000 gallons go now?—It goes into a stream called the Lostock, and eventually into the Ribble.

11461. Then none of it goes into the sewers?—None at the present time, but I may say that I should desire to have the power to turn a portion of the effluent into the sewers.

11462. (*Sir Michael Foster.*) A particular portion?—A particular portion, what I may call the worst portion of our effluent, into the sewers, provided it could be done so without having an injurious effect on the subsequent treatment of the sewage.

11463. How is that distinguished from the rest—that part?—Well, I will explain. The worst portion of our effluent is that which is caused by boiling the cloth. We boil it, as probably you know, with lime and soda, and in boiling it with lime and soda we get out the size, and the stuff with which it is boiled contains the worst of our pollution. In my own case it might amount to perhaps 10,000 or 15,000 gallons a day.

11464. Is that very powerful?—Yes, it is very strongly alkaline.

11465. Strongly alkaline?—I think, subject to that being put in and spread over a space of 12 hours, it might be put into the sewage of the district without injuring it. That is the power which for my part I should like to have.

11466. And that would leave the rest of your waste of a much milder and less noxious character?—I think so. I do not think even then the rest would be fit to turn into the river without settlement, and possibly some form of filtration. Of course, if it would do the local authority harm then I think the thing would not be desirable.

11467. (*Professor Ramsay.*) May I ask whether you use methodical washing; do you use the spent liquor to treat the first stuff that comes in, and the next, and so on?—We do not, no.

11468. Is it not an advisable thing to do; would it not economise the amount of liquid you would turn out very largely?—I do not think so; if it is done it is done in the form of taking the water and settling it; it is not done by passing it through first one washing machine and then another washing machine. (*Mr. Ross Gemmell.*) Some of the machines in the print works are arranged on that method; it is done for the purpose of economising the water.

11469. It would also economise your effluent; you would have less to deal with?—Yes.

11470. (*Sir Michael Foster.*) And is it equally valuable for the purpose; do you wash equally well so?—Yes, oh yes, quite. (*Mr. Stanning.*) There might be a little difference of opinion about that. I would rather wash with clean water than with dirty.

11471. (*Professor Ramsay.*) But you ultimately wash with clean water?—Ultimately, but still——. (*Mr. Ross Gemmell.*) Mr. Stanning is speaking of white, and I am speaking of print, dyed, and coloured.

11472. (*Major-General Carey.*) Has it ever been suggested that they should take this portion of your effluent?—(*Mr. Stanning.*) I think at one time they agreed to do it, but for some reason we have discontinued sending it in.

11473. (*Sir Michael Foster.*) Your effluent from the print works is of a different character?—(*Mr. Ross Gemmell.*) Yes, in a way, it contains much more colouring matter.

11474. A good deal of colouring matter?—Yes, sometimes.

11475. And less size?—Yes, I should say, perhaps.

11476. Not a great difference?—I am not certain about that.

11477. (*Professor Ramsay.*) Do you do anything to remove the colouring matter?—Yes, we have settling tanks at most of the works; of course, the works of the Calico Printers' Association, almost the whole of them; I think the whole in the Lancashire and Cheshire district drain into the rivers, not into the sewers at all.

11478. (*Sir Michael Foster.*) Are you able to remove the colour?—Not entirely; still, we are under the Mersey and Irwell Joint Committee; of course this goes into the Ship Canal.

11479. (*Professor Ramsay.*) We know what that is like?—Yes. (*Mr. Stanning.*) I may say that we dye as well as bleach, and the colour is not absolutely removed, but there is not very much colour left when the whole of our effluent is mixed together; there is very little coloured matter.

11480. Does precipitation in the tank remove colour to a great extent?—(*Mr. Ross Gemmell.*) Well, some colours will not remove at all.

11481. (*Sir. Michael. Foster.*) You say some colours; I mean how would you distinguish them; what colours, for example, can you not; what is the class of colour that you cannot remove in that way?—Well, alizarine and some direct dyeing colours would be very difficult to get clear.

11482. (*Chairman.*) Have you applied to the local authority to take any of your effluent?—(*Mr. Stanning.*) No, I have not. Some time ago I did, and they agreed to take it, but it is 14 or 15 years ago, and we discontinued sending it down simply because it was inconvenient, but it is quite possible we might like to have that power again.

11483. Did you once send it into the sewers?—A portion of it, a small portion of it; just the portion that I referred to.

11484. You gave up doing that for your own convenience?—Yes.

11485. (*Sir Michael Foster.*) How does the local authority treat its sewage, do you know?—Yes; it passes it through a tank and then by irrigation.

11486. It has an adequate quantity of land?—Yes, a good quantity of land; the treatment is quite successful, quite.

11487. (*Chairman.*) You would agree that local authorities should be safeguarded against any injury to their sewers?—Certainly, without doubt.

11488. And should you say, speaking as generally as you can, that manufacturers are prepared to adopt means for removing solids and grease from their trade refuse before they allow it to discharge into the sewer?—I certainly think so, in Lancashire at any rate. (*Mr. King.*) Not in the large towns, where there is no space; they cannot. (*Mr. Stanning.*) I thought that was a general question. Of course, where works are in the middle of a large town like Manchester, I think the conditions are entirely changed.

11489. But you think that they are prepared to adopt such means generally wherever it is possible to do so?—Yes, certainly, wherever it is possible.

11490. (*Sir Michael Foster.*) But in a large town, where they are cramped for space and so on, they should be allowed to discharge all into the sewer?—I think so; they pay large rates, and I think they have the right to the use of sewers unless there is some very special reason against it.

11491. (*Professor Ramsay.*) Do you discharge any spent bleaching liquor into the sewer; any bleaching liquor which still contains a power of bleaching to any extent, which contains chlorine?—Well, in any well-arranged works the whole of the chlorine is used up in the bleaching itself.

11492. None left over?—Practically nothing. (*Mr. Ross Gemmell.*) Nothing.

11493. (*Chairman.*) In the event of a dispute between the local authority and a manufacturer, do you think there ought to be some legal tribunal before whom it could be tried?—(*Mr. Stanning.*) Yes, we do think so.

11494. And what sort of tribunal?—Well, I confess I am unable to answer that question.

11495. I mean, would you have it a central tribunal in London, or would you have a local tribunal?—My own impression is that there is very much to be said for both sides. A central tribunal in London would take a broader view, and perhaps deal with the matter more

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equitably all round; on the other hand, they have not the special knowledge which is required in dealing with these cases.

11496. (*Sir Michael Foster.*) You mean the local knowledge?—Yes, I beg your pardon, the local knowledge.

11497. That can be obtained readily, can it not, by inquiry?—Yes, it all depends upon the man.

11498. In your answer you are thinking of the one-man tribunal? — Yes, we were rather. (*Mr. Ross Gemmell.*) The Government Inspector. (*Mr. Stanning.*) The Government Inspector, that is what we were thinking of.

11499. The question would cover, you see, a Board; did you look at the interim report we published?—No, I have not seen that.

11500. In which we suggested what we spoke of as a Supreme Rivers Authority, a central authority in London for dealing generally?—I am afraid I have not seen that, no.

11501. That was not meant to be an arbitrator, simply one man, but a constituted Court having at its disposal adequate technical ability? (*Mr. Stanning.*) The proposed Court would seem to be very good, but we have not considered this suggestion. (*Mr. Ross Gemmell.*) We were thinking more of the ordinary Factory Inspector.

11502. (*Professor Ramsay.*) You are not under the Alkali Act?—No, we are not.

11503. (*Sir Michael Foster.*) They would have technical knowledge at their disposal?—Yes.

11504. They can in any particular case acquire the local knowledge also?—Oh, no doubt they could. I may say I have no authority to answer that question, because we have not considered it in that form, but I am sure we are anxious that we should meet the views of the public in this matter and do what is right in it—most anxious. May I call attention to one thing; perhaps you know in our reply we say "the old-established manufacturers." Now we do not want by any means to create a monopoly, but we do think that in the case of any new works which are established they ought not to be allowed to establish themselves except they prove that they have facilities for dealing with their effluents, because we know from our own sad experience what a difficult thing it is for works which have no land, and can get no land, to deal with its effluent.

11505. (*Chairman.*) What should you say were the difficulties the manufacturer usually meets with in dealing with the local authority, and what are the reasons that local authorities generally advance for refusing to let trade refuse enter the sewers?—In our trade we have not often come into collison with the local authority. It has not come within our experience, but I think wherever we have we have been able to make satisfactory terms with them. I believe three of our works turn their effluent into public sewers. In one case when they made terms with the local authority I believe they paid a fixed sum down, and they got the right, the corporation gave them the right to turn their effluent into the sewer. In another case they turned it into a stream, but they treat it before they did so, so that that is practically not turning it into a stream. In the third case I believe they turned the whole of the effluent into what has become a public sewer by the process of building which has gone on; the works hav gradually become enveloped by buildings, and wha was a stream has now become a sewer. (*Mr. King.*) I think the question is one of expense and the limitatio of the borrowing powers of the urban districts, speaking of my own district.

11506. Oh! I see that the local authorities cannot get the money to make a sewer big enough?—Exactly, and works big enough, because the construction of tanks and amount of land depends upon the volume of the effluent. As Mr. Stanning has pointed out, the volume of manufacturers' effluent is in excess of the volume of the urban districts, and where hey have borrowing powers only to enable them to make sufficient works for their own sewage it is absolutely impossible for them to take any manufacturers' effluent. They cannot borrow the money to carry out the works even if they wish to do it. I think that is more important in many of these districts than any question of doubt as to what the law is between the three Acts. In any case, no law clerk for an urban council will take upon himself to advise a council as to whether they are bound to take in a manufacturer's effluent. He looks at one Act and he thinks they are; he looks at another Act, he thinks he is not sure. They are in that condition that it is quite impossible for a lawyer to advise upon the point.

11507. Do you know what the limitation of borrowing powers is?—Twice the rateable value in urban districts. I am the chairman of the urban district council in my own district, and we have that particularly coming on now. Our rateable value is £30,000; we have borrowed already £18,000 of that for water works and other improvements. We are now engaged in preparing a sewage scheme, and the sewage scheme to take in the ordinary drainage of the urban district will cost at least our remaining £12,000. We can only do that by absolutely excluding manufacturers of various kinds in the district. If they insisted on coming in we simply could not go on; there would be no sewage scheme at all.

11508. Might we have the name of your district?—Bollington Urban District, near Macclesfield.

11509. (*Sir Michael Foster.*) The manufacturers pay rates, I suppose?—Yes; they want to come in. We have a print works, a paper staining works, and a brewery.

11510. (*Chairman.*) They want to come in now?—Yes, they want to come in; we have had to appeal to them as a council. Well, if they insist on coming in and opposing our scheme, their position would be this: When we applied to the Local Government Board to borrow money to carry out our sewage works, if these manufacturers want to come in they would have to appear at the inquiry and say: "Well, look here, they are making no provision for our trade effluent." As an urban district we appear and say: "Well, if you do that our sewage scheme is knocked on the head; it will double our expenses; our borrowing powers are limited." We are between the deep sea and the devil in that.

11511. (*Major-General Carey.*) Have all the works carried out by the urban district been under the Public Health Act?—Yes.

11512. If the water undertaking had been carried out under a Local Act it would not come under the limits of borrowing?—The gas works are in a local Act, but the water has been after a local enquiry.

11513. (*Chairman.*) Then the manufacturers are in rather an unfortunate position, are they not; because they are paying the rates, and at the same time you do nothing for their trade effluent?—Exactly. My own particular works are just outside the urban district, so the only means by which I could come in would be by arrangement; but with regard to the manufacturers in the district this is rather a hard case.

11514. (*Sir Michael Foster.*) But that is mainly stopped by a limitation on your borrowing power?—Yes; at any rate that overrides all other questions.

11515. Because the question of the extra expense might be met possibly by an arrangement between them and the local authority. You say there are two things—the limitation of your borrowing powers and the great expense it would be to you?—Yes.

11516. The former one, the limitation on the borrowing powers, is the most essentially difficult?—Well, I mean to say that overrides any question as to whether we are bound to take them or not. We have not raised any question with the manufacturers as to whether we are obliged under the Acts to take them in; we simply say: "Well, whether we are obliged or not we could not do it." I think that applies in a good many cases.

11517. You think that applies in a good many cases?—In a great many urban districts. The only possible suggestion would be whether in a district of that kind it would be better to have a larger drainage area. The country below, the people in the rural districts below, benefit by the purification of the stream, whethey they should not to some extent be charged with the cost of it.

11518. I gather that your difficulties are that so treating your effluent you are allowed to turn it into the stream?—(*Mr. Ross Gimmell.*) Yes. In our case, the print works, we do not turn it into sewers at all, we turn it into the streams. (*Mr. Stanning.*) It is

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only a very small proportion indeed where the sewer comes in.

11519. Your difficulties are of that kind that you have to acquire sufficient purification to justify it being turned into the stream?—Yes.

11520. And I understand your association is engaged in experimental enquiries as to the best way of treating your refuse so as to secure that?—As individuals, not as an association.

11521. Not as an association?—Individuals are; I may say I myself am.

11522. At your own expense?—Well, at the expense of my firm.

11523. It has not been undertaken by the Association?—No.

11524. Although such matters do effect very largely the welfare of all, do they not?—They do; indeed they do.

11525. (*Colonel Harding.*) One is rather surprised to find that your association has not recognised its responsibility in these matters?—We have been very busy in other matters up to this time; ours is a new association.

11526. Still, from the point of view of the general good. This is an important thing also; yours is surely a very wealthy association also?—We are a wealthy body, but should not be justified in spending money on experiments when we already have all the necessary information from the experience of our various branches.

11527. But the expense of experiments and the engagement of an expert would fall very lightly upon the individual manufacturer if the association took up the question?—I think that a very large amount of knowledge has already been obtained in Lancashire with regard to the purification of streams. They have two authorities there—the Ribble——.

11528. (*Sir Michael Foster.*) The question is the problems connected with your particular refuse, your particular works?—(*Mr. Ross Gemmell.*) If I may speak for the print works, in many cases we are doing it; we think well, and spending a great deal of money upon it.

11529. (*Colonel Harding.*) And are you satisfying the Rivers Board?—Yes, more or less. Sometimes there are lapses in all these schemes.

11529*. That is in regard to the printing effluents?—Yes.

11530. (*Sir Michael Foster.*) They are not so serious as those from bleach works?—(*Mr. Stanning.*) More so.

11531. And their means are actually known?—Certainly.

11532. I mean the problem is solved, no further inquiries are necessary?—(*Mr. Ross Gemmell.*) I do not know whether we satisfy those gentlemen or not, but in our works we spend £400 or £500 a year in doing it in the print works.

11533. In the purifying process?—Yes.

11534. But not in inquiring whether the purification can be carried further?—Not in experimenting further.

11535. (*Colonel Harding.*) That is, from your own personal experience you believe it to be practical, within reasonable limits of cost, to purify the effluent from printing works?—Yes, I should say so, within reasonable limits; of course, the limit has never been defined by the Mersey and Irwell Joint Committee.

11536. But you bring about a very considerable improvement?—Certainly.

11537. (*Mr. Stanning.*) Without doubt the Ribble is considerably better than it was?—There is no question about it.

11538. And your Association recognise on behalf of your members the responsibility of the manufacturer to purify effluents before they are turned into the streams?—Certainly. (*Mr. Ross Gemmell.*) We have to do it.

11539. With regard to refuse from bleach works, you told us you were able to bring about at your work considerable improvement, though you admitted that the result was not satisfactory?—(*Mr. Stanning.*) Yes, it is fairly satisfactory.

11540. (*Sir Michael Foster.*) You yourself are engaged in experiments to see if you can make it more satisfactory?—I am.

11541. (*Colonel Harding.*) I should like to see your Association taking up the difficult branch you are endeavouring to deal with, and to find out in the interests of all manufacturers the best way of dealing with trade refuse?—I hope we have sufficient knowledge now to enable us to go on with experiments which ought to demonstrate one thing or the other.

11542. (*Sir Michael Foster.*) Which is the one thing and which is the other?—The one is whether by bacterial or other treatment present methods can be improved, the other whether we must be content with precipitation and filtration. We have improved the thing very much, but it is not so good yet as to make it an effluent fit to turn into any stream.

11543. In which fish live?—I will not say that, but at any rate clear.

11544. And not a nuisance?—And not a nuisance, so that it will not putrify. (*Mr. King.*) There is no known method of getting rid of the soda in solution; it is too dilute. You cannot do it by precipitaiton or any other chemical means.

Have any experiments been made with a view of the possibility of removing the soda?——

11545. (*Professor Ramsay.*) You can make it into common salt or into sulphate, which comes to the same thing?—By concentration; it is difficult to do that in any volume.

With the right quantity of acid of some sort or other you could neutralise your alkali?——

11546-7. (*Sir Michael Foster.*) It is not a question of alkali; it is a question of actual saline material discharged into the stream?—Exactly.

(*Professor Ramsay.*) The amount of salt water?

11548. (*Sir Michael Foster.*) After you make it common salt?—You cannot get rid of the soda without evaporation, and you cannot have evaporation of 800,000 gallons a day. (*Mr. Stanning.*) May I point out, sir, that the very point Mr. King has raised now is where I think the public sewer would help the bleachers if the concentrated liquors, soda ash liquors, were allowed to be turned into the common sewer; it would diminish the alkalinity of the bleachers' effluent. If they could turn this concentrated effluent into a public sewer without injury to the public sewer, that would be a most valuable aid to us. Mr. King's effluent is more alkaline than mine. My own effluent is very, very slightly alkaline. I may say, with regard to my own works, that we have begun to deal with this question. The first question was to settle off the solid matters. That was the first thing we did. We do that so effectually that we remove out of our effluent about 1,000 tons of sludge every year.

11549. What do you do with the sludge?—Well, we have done all sorts of things with it; that is one of our difficulties. (*Mr. King.*) That is a very serious difficulty.

11550. It has no value, I suppose?—(*Mr. Stanning.*) I am not quite sure of that; if it is placed where the air can get to it, and allowed to ripen, the land upon which it has been placed has done extremely well.

11551. Have farmers seen that?—Some of the farmers have taken it, and used it and liked it, but I will not venture to say anything very positive about that; I only speak of my own experience. We keep 1,000 tons out of the stream every year, so you will know we have done a very great deal. (*Mr. King.*) That has been done in all works.

11552. (*Professor Ramsay.*) What is the percentage of soda in the remaining effluent?—I could not tell you; it is very dilute. There is the difficulty; our thin effluent is the result of washing the cloth. After the soda boils you get an immense volume of soda and dilute matter in very dilute solution.

11553. Caustic and carbonate; you do not take any steps to neutralise that before it goes into the streams?—We mix our acid wash waters with it. The bulk of our effluent consists of two portions—one the result of washing the cloth after the lime or soda boil. This is an alkiline effluent. The other portion is the result of washing the cloth after the grey and white dyes, and is an acid effluent. By mixing the two wash waters together a certain amount of precipitation results, and the combined effluent remains slightly alkaline.

11554. What acids?—Sulphuric and hydrochloric. If those two are mixed, to some extent that precipitates a certain amount of——(*Mr. Stanning.*) In our

case we take the whole of the water which goes into the works; we do not precipitate any portion of it; that makes it all very slightly alkaline.

11555. (*Sir Michael Foster.*) That brook which has now become a sewer that you spoke of——?—That is not in my works.

11556. Does that discharge lower down into the Ribble?—I do not know where it goes; I am sorry I cannot give you the information. It is not on the Ribble, at any rate. (*Mr. King.*) It is on the Irwell.

11557. It is on the Irwell and discharges into the Irwell, or probably the Ship Canal?—(*Mr. Stanning.*) I am informed that this effluent goes into the Salford main sewer.

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11558. Where it was treated according to this new method and goes into a sewer?—I think it goes into a sewer; that is my own impression. I do not wish to state that positively.

11559. It has, simply through building in that area, from being an open sewer become a closed one?—I think so. I should not like that answer to be taken as an actual fact, because I do not know.

THIRTY-NINTH DAY.

Tuesday, 3rd June 1902.

PRESENT:

Colonel HARDING in the Chair.

Sir MICHAEL FOSTER, K.C.B., M.P., F.R.S.
Mr. W. H. POWER, F.R.S.
Professor RAMSAY, F.R.S.
Dr. BURN RUSSELL.

Mr. F. J. WILLIS, *Secretary.*

Mr. J. H. MILLS, called; and Examined.

Mr. J. H. Mills.

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11560. (*Chairman.*) You are clerk and surveyor to the Crompton Urban District Council?—Yes, sir.

11561. Where is the district with which you are connected?—It is between Rochdale and Oldham.

11562. I see you do not admit manufacturers' refuse into your sewers?—Not by permission. We have a large manufacturer who does it, but it has been done surreptitiously. I have got a copy of the correspondence which would set forth what it is. I could leave that here.

11563. Well, we will deal with that perhaps presently. Evidently you consider it to be a part of the duty of the local authority to receive effluents into the sewers?—Not as much as we get.

11564. What is generally the nature of the effluents that you get in your district?—We have only one manufacturer in our district; it is large bleaching works—kear liquor.

11565. And is that the firm specially referred to, Messrs. A. and A. Crompton?—Messrs. A. and A. Crompton; that is so.

11566. You have only the one manufacturer?—That is so.

11567. Well your experience, of course, is strictly limited, and it is that this manufacturer does connect with your sewer, although, apparently, it is not done with your consent?—It is not done with our consent.

11568. How long has he been passing effluents into your sewer?—Six or seven years.

11569. And in considerable volume?—Yes, now.

11570. And what is the nature of the effluent?—It is kear liquor from bleach works.

11571. What is its chemical composition?—Hydrochloric acid is in it considerably; of course, I could not give you the chemical analysis of it. That is in hand now. If I had come up on Thursday I could have brought Mr. Scudder's report with me; it would have been ready. Mr. Scudder is Sir Henry Roscoe's assistant.

11572. What is the relative proportion of this effluent to the domestic sewage?—Well, I should say we get about 100,000 gallons per day from them.

11573. And what is the total?—And our normal flow is about twice that.

11574. (*Mr. Power.*) It will be one-third the flow?—Yes.

11575. The dry weather flow of sewage, you are speaking about—one third of the dry weather flow?—Yes.

11576. How many volumes do you treat in times of storm?—A lot of it has to go by when there is a storm, we could not collect it all.

11577. But you do take storm water, do you not?—Oh, yes, yes.

11578. (*Chairman.*) Then what is the effect upon your treatment of this admixture of bleach work effluents?—Well, it affects us in this way, that I do not think we can treat it as well as we could without their stuff in. Then, again, we cannot satisfy the Mersey and Irwell standard absorbing one grain of oxygen per gallon, because this stuff they send down would in some cases absorb as much as 30 or 40 grains in three minutes.

11579. What is the nature of the treatment that you give to your sewage?—We precipitate it by means of alumino ferric and then we filter it through polarite beds.

11580. And did you before the admixture of these trade effluents obtain satisfactory results?—We did, yes.

11581. Is the unsatisfactory result that you now attain due to your having to deal with a larger volume than your plant will properly deal with, or is it really due to the character of the effluent itself?—To the character of the effluent, most decidedly.

11582. (*Professor Ramsay.*) Might I interpose one question here: are you quite sure that the very large amount of oxygen absorbed is due to the admixture of bleach work effluents, and not to some other cause?—I should not like to express an opinion as a chemist; I am not a chemist. I do not deal with the chemical part of it. We are having a report made by Sir Henry Roscoe's assistant now, with a view to prosecuting these people to make them take it out.

11583. Have you seen the report?—No, I have not got it yet; I would have had it if I had come here on Thursday.

11584. Are you sure it is on those lines; are you sure that Mr. Scudder will declare that the effluent is injurious?—I think so.

11585. It appears to me questionable whether a bleach work effluent is one that would likely lend itself to much organic deterioration?—Well, it is sometimes very acid and sometimes very alkaline; we get it in mixed quantities; they do not neutralise it, or do anything with it in their own works, they send it down to us indiscriminately. They used to send it into the river direct themselves until the Mersey and Irwell people stopped them.

11586. (*Chairman.*) Then what kind of result do you obtain by your treatment of this mixed sewage and trade

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effluent?—We have had a bad effluent only about twice, I think.

11587. And would any extension of your plant meet the case, or is it that the bleach work effluent really prejudices the treatment itself?—Certainly I think it does.

11588. You are advised by experts that that is so?—Yes.

11589. Then what are you attempting to do in this matter?—We have taken counsel's opinion, and Mr. Scudder—that is Sir Henry Roscoe's assistant—has been taking samples for about three weeks, and he will report to us with a view to our prosecuting this firm, to compel them to take it out.

11590. (*Professor Ramsay.*) Does this firm pay a large part of the rates?—Well, they are certainly large rate-payers.

11591. Can you give us any idea as to what proportion of the rates they pay?—I did not anticipate that question, sir.

11592. (*Mr. Power.*) Before they send it into your sewer do they submit it to any treatment themselves at all?—No.

11593. (*Chairman.*) You think that the local authorities ought not to be bound to receive trade effluents?—Not unless they pay for it.

11594. If the manufacturer is willing to pay the extra cost to which the authority would be put, do you think it would be proper for the authority to take it?—Well, not in a case like this; I mean if they paid what some large towns charge, about £1 per million gallons, well it would not pay us to do it for £1 per million gallons.

11595. Well, in cases where an authority has a large number of manufactories in its district, do you not think that it would be practicable for the authority to receive a variety of effluents, many of which would neutralise each other, and none of which would probably be of excessive volume?—In a large town I think it would be advisable.

11596. But in your particular case, dealing with one firm only, which turns a large volume of a specific effluent, you see grave inconvenience in the authority being compelled to receive it?—Undoubtedly.

11597. And has this firm land upon which it could itself treat its effluent?—Yes, it is upon their own estate.

11598. And your opinion is that in this particular case this firm ought to do the work itself?—Undoubtedly.

11599. Is there any part of the work that it might carry out which would facilitate your reception of the effluent; could they subject it to a preliminary treatment?—They will not do anything.

11600. Yes, but as a matter of possibility, could they do so?—Yes.

11601. Is there any treatment to which they could subject their effluent which would facilitate its reception and treatment by you?—I have had no practical experience about that; I believe they can neutralise it.

11602. You think that where effluents are received into sewers it is right that the manufacturer should carry out certain preliminary works, such as the removal of solids, or of grease, or some analogous works of that kind, before the effluent is turned into the sewer?—Yes.

11603. But in this particular case the firm refuse absolutely to carry out any preliminary treatment?—They do.

11604. Now as to the condition of the law, what is your view as to the position of local authorities with regard to the law in this matter?—Well, I think that is more a matter for a solicitor to express an opinion about.

11605. Well, but give us your experience; you have consulted lawyers, and do you find that the law is clear?—I hardly think it is, not in the Rivers Pollution Act.

11606. Your experience then in consulting lawyers is that you do not quite see your course clearly?—No; if you go to two lawyers, you get two different opinions.

11607. Not an unusual result to find, is it?—No.

11608. Where does the firm in question obtain its water supply?—Off their own estate.

11609. From wells?—No, it is water that comes off the hillsides, and there is compensation water from the Oldham Corporation Works that goes down this stream too; they have any quantity of water, this one firm.

11610. Then there are no riparian rights compelling them to turn it back into the stream?—No; nearly all the water that comes is on their own estate.

11611. In view of the limited character of your experience, I think it is unnecessary, myself, to ask you any further questions?—Shall I leave a copy of this correspondence we have had and counsel's opinion?

11612. Yes, you might leave them (*documents put in.*)

11613. (*Dr. Burn Russell.*) What is the population of your district?—About 13,500.

11614. Do you know the number of hands that this firm of Crompton employ?—They employ about 700 hands, but they would probably employ about 80 or 90 in the bleaching works, and they work night and day.

11615. Do these people mostly live in your district?—The proprietors, you are speaking of?

11616. No, the hands?—Oh, yes, the hands all live in the neighbourhood.

11617. I think you have already said you cannot give us any idea of the incidence of the rates—the total rates?—Well, they probably pay about £300 a year in rates.

11618. Out of a total of how much?—Out of a toal of about 10,000 or 11,000.

Mr. A. J. T Simpson, Mr. J. Lord, and Mr. K. Walton.

Mr. Alderman J. T. Simpson, Mr. J. Lord, and Mr. Keighley Walton, called; and Examined.

11619. (*Chairman.*) Mr. Alderman Simpson, you are Chairman of the Halifax Sewage Committee?—(*Mr. Alderman Simpson.*) Yes.

11620. I understand Mr. Lord is the Engineer?—(*Mr. Lord.*) Yes.

11621. And that Mr. Keighley Walton, who is also with you, is the Town Clerk of Halifax?—(*Mr. Walton.*) That is so, sir.

11622. What is the population of your town?—(*Mr. Alderman Simpson.*) 106,000.

11623. And is there much variety of manufacture?—Yes, very considerable.

11624. What are the leading branches?—Wool scouring, pickling for what is known as wire drawing, and, of course, dyeing in all its branches; silk spinning, breweries—a very considerable number of breweries—and a considerable amount, of course, of tool making; tool manufactories—but that does not affect the sewage much——

11625. Do the silk mills turn out a very bad effluent?—A very bad effluent, yes, spinners turn out a considerable amount of very gummy matter.

11626. That is from the washing of the cocoons in connection with silk waste production?—Yes, that is so.

11627. What has been the rule of your Committee in regard to the admission of trade effluents into your sewers?—Up to now we have taken all in that are not on the stream, so that we have practically the effluents of the whole town, excepting the few manufactories that are on the stream.

11628. All these turn direct into the stream probably, because it is inconvenient to turn into the sewer?—That is so, but now they are asking to come into our sewers owing to the pressure of the West Riding Rivers Board.

11629. (*Sir Michael Foster.*) What is the proportion of those who draw from the stream to the others?—(*Mr. Walton.*) We take about one-third of the trade refuse, and two-thirds go into the stream; all the large manufactories go into the stream.

11630. (*Chairman.*) Then how long has this reception into the sewers of trade effluents been going on at Halifax?—(*Mr. Alderman Simpson.*) Oh, ever since it was a town.

11631. You probably find that there would be considerable difficulty in stopping them?—I fear so. Of course, we are hoping that in a little time, by the assistance of the manufacturers, we may get some system by which they will put down tanks to hold back the solid matter. We had a conference with them quite recently, and told them that in seeking that conference we were trying to work amicably with them, but, unfortunately, after an hour or an hour and a half's conversation, we did not get any nearer, and practically they wished us to abandon these Regulations that we were just promoting and to go on as they had been in the past.

11632. Then in regard to those who are on the stream, are they compelled by the riparian owners to return to the stream the water that they draw from it?—Well, that is a question which will have to be decided. At the present time we have not taken them into our sewers.

11633. But, if you did, do you not think there would be some objection made by riparian owners?—I hardly think so, because the largest of them are near the outfall, where the stream falls into the River Calder.

11634. So that the passage through your sewage works would not cause a serious inconvenience?—I do not think it would cause a serious inconvenience to them. Had it come higher up the stream it would have caused them considerable inconvenience.

11635. Then have these people to pump to get into your sewers?—No, the sewer runs down the bed of the stream.

11636. (*Sir Michael Foster.*) The sewer runs down the bed of the stream?—Yes, in an iron sewer.

11637. (*Chairman.*) In the bed of the stream?—In the bed of the stream, yes.

11638. Have you formed any opinion as to the relative volume of these combined trade effluents and your ordinary sewage?—Yes. (*Mr. Walton.*) If we took in the whole of the trade effluents we should practically double our daily flow.

11639. And what is roughly the volume of what you now take in?—Three million gallons per day; that is the total that we now take into our works.

11640. You mean the total of domestic sewage and trade effluents combined?—Yes, sir.

11641. Then what is about the relative volume of the trade effluents you are now taking to your domestic sewage?—(*Mr. Alderman Simpson.*) We reckon about half; I think just about half. (*Mr. Walton.*) One and a quarter for the trade, and about one and three-quarters for the domestic.

11642. It approaches one half?—Practically half, yes.

11643. Now, what is the effect of this trade refuse upon the treatment of your sewage?—(*Mr. Alderman Simpson.*) Well, as you are perhaps aware, we are about to adopt a bacterial system, and the amount of soap-suds that we have to contend with now, and also the large amount of colouring matter that comes down from the dyers will necessitate a very much larger capacity for settling tanks and also for filter beds—a very much larger area than we should otherwise have put down.

11644. But does any inconvenience arise, apart from the necessity of extending the works, to deal with the larger volume?—No, I do not suppose it will, provided we can get the manufacturers, who are now on the stream, and who are asking to come in, to take out their solids, and adopt certain regulations which we have here printed, whereby instead of letting their refuse come in a large volume they will let it go into tanks, and put into the tanks small pipes so that there may be a continuous flow from a one inch or a half-inch pipe all the day long. Take, for instance, the wire drawers, where a large amount of vitriol is sent down; that in itself, as you know, is not bad to the sewage, if it is spread over a large surface, a small quantity running in at a time instead of coming in a very large flush. The following are draft regulations for admission of trade refuse into sewers:—

1. All liquid trade refuse from the manufactory shall be passed into and through suitable settling tanks to be approved by the Corporation, the same to be constructed and at all times maintained by and at the cost of the owner to the satisfaction of the Corporation.

2. By means of the settling tanks and by such other means as shall be from time to time approved by the Corporation, the resulting effluent shall be made:—

(*a*) Free from any substance, matter, or thing which shall or may (either alone or in combination with the ordinary sewage).

(1) Be injurious to the sewers or the sewage therein.

(2) Cause or create a nuisance either within or without the sewers.

(3) Be dangerous or injurious to health either within or without the sewers,

(4) Unduly interfere with the purification of the sewage.

(*b.*) Free from any substance, matter, or thing, the discharge of which into the sewers may contravene any public or local Act of Parliament or rule of law.

All suds to be treated for the removal of grease.

3. The owner shall remove as frequently as may be necessary from the settling tanks all solid refuse and solid matter which may be from time to time deposited therein.

4. Only the effluent from the settling tanks which complies with Regulation 2 shall be discharged into the sewers.

5. The maximum aggregate daily quantity of effluent which may pass from the manufactory into the sewer shall be agreed between the owner and the Corporation before any connection with the sewer is made, or any works for that purpose are commenced. The size and capacity of the drain for conveying the effluent from the manufactory to the sewer shall be determined by the Borough Surveyor, and shall be such as having regard as well to the agreed maximum aggregate daily quantity of effluent as to the intended inclination of the drain will be necessary to secure that only such agreed quantity shall and may be conveyed into the sewer as near as possible at a uniform and regular rate of flow throughout the 24 hours of every day.

6. The said drain for effluent shall not at any time be used for the purposes of conveying domestic sewage into the sewers of the Corporation unless by express permission of the Borough Engineer. The owner will not connect any drain with the sewers of the Corporation without first obtaining a permit from the Borough Surveyor, and complying with the regulations relating to the connection of drains with main sewers which may from time to time be made by the Corporation, and be in force in the borough under the provisions of the Public Health Act, 1875.

7. The owner shall provide and efficiently maintain a tank or receptacle at the manufactory, sufficient to hold at least one-half the agreed maximum aggregate daily quantity of effluent, and shall cause the effluent to pass into such tank or receptacle and be thence conveyed by the drain into the sewer.

8. There shall be constructed and maintained by and at the cost of the owner at or near the outlet of the drain into the sewer an examination shaft and apparatus so designed as to enable the Corporation or their officers to obtain at pleasure from time to time samples of the effluent discharged into the sewer.

9. The works shall be constructed and carried out to the satisfaction in all respects of the Borough Surveyor and shall be at all times subject to these regulations and the Acts of Parliament (public or local) bye-laws and regulations for the time being in force in the Borough of Halifax in relation to the subject matter of these regulations. In particular in the works of excavating for and making and maintaining the drain or anything therein or connected therewith the owner will adopt such measures and generally carry out the works in such manner as shall be suggested or required by the Borough Surveyor for ensuring the satisfactory execution of the work for effectually protecting the sewers, drains, gas and water pipes, wires, tram lines, and apparatus for ensuring perfect stability for the surface of the street, and for preventing the complete stoppage of the traffic thereon. Provided that the fact of the Borough Surveyor giving or failing to give any instructions or directions respecting the works shall not relieve or exonerate the owner from any obligations or liability imposed upon him by these regulations or at law.

10. Any work of removing the pavement and flagging of the street and of restoring and making good the same

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shall be done by the Corporation at the expense of the owner and the owner shall pay any such expense to the Corporation on demand.

11. The owner shall permit the Borough Surveyor or any other duly authorised officer of the Corporation to enter the manufactory from time to time, and to inspect the condition of the drains and settling tanks.

12. If at any time the works provided for by these regulations or any of them or anything therein respectively shall in the opinion of the Corporation or the Borough Surveyor be in a dilapidated unsafe inefficient or unsatisfactory condition or if the same shall not be kept and maintained in proper working order or shall not be duly and properly fulfilling these regulations in all respects or if proper arrangements for removing the solids from the trade refuse are not in regular and constant operation it shall be lawful for but not obligatory on the Corporation in addition and without prejudice to their other remedies by statute or contract at the risk and cost of the owner (after first giving to the owner one week's notice in this behalf) either to repair reinstate or complete the same as in their absolute discretion may think fit and to enter upon the property of the owner for the purpose of executing the necessary works in that behalf. The owner shall pay to the Corporation on demand the cost to be incurred by the Corporation in any such work of repair reinstatement completion or disconnection, such cost to be from time to time ascertained and certified by the Borough Surveyor, whose decision shall be final and binding on all parties.

13. Any costs and expenses which may be incurred by the Corporation and which under these regulations shall be repayable to them by the owner shall include five pounds per centum for superintendence, and shall carry interest at four pounds per centum per annum from and after the expiration of one calendar month after service upon the owner of a demand for payment of such costs and expenses.

14. The arrangements contemplated by these regulations do not extend to the reception into the sewers of surface and storm water, or of water which has been taken or diverted from a river, stream, or canal.

15. The owner shall enter into an agreement to be prepared by the Town Clerk for securing the due observance of these regulations.

16. In these regulations the following words have the meanings here assigned to them:—

"Owner" means and includes the owner and occupier for the time being of the manufactory.

"Manufactory" includes any works, manufactory, or premises in the Borough of Halifax in which liquid trade refuse is produced.

"Borough Surveyor" means the Borough Surveyor for the time being of the Borough of Halifax.

And words in the singular number include the plural and words in the masculine gender include the feminine.

To the Corporation of the County Borough of Halifax.

I apply for your permission to make a connection from my works situate..........................with the sewer in ....Street, in the Borough of Halifax, for the purpose of carrying the liquids from such works into such sewer.

The trade or process carried on at such works is that of a........................

The maximum daily volume of liquids issuing from such works is about.......................gallons.

In the event of my application being complied with, I undertake that the foregoing regulations shall at all times be duly observed by the owner and occupier for the time being of the said works.

The owner and occupier of the works are prepared to enter into an agreement for that purpose, to be prepared by the Town Clerk of Halifax.

The names and addresses of such owner and occupier are:—

Owner ....
Occupier ....
Signature ....
Address ....
Date ....

11645. Before passing on to that, I should like to ask you again about your treatment. You are about to adopt some bacterial filters you tell us?—Yes.

11646. But what is the first process which you have now at work?—Simply open septic now; a very large volume of open septic tanks 4,500,000 gallons, that is, a day and a half's outfall.

11647. And how long have they been in operation?—Only six months. (*Mr. Walton.*) February last year.

11648. And so far as your short experience goes with these septic tanks, what results have you obtained from these mixtures?—(*Mr. Alderman Simpson.*) Well, quite 50 per cent. cleansing of the effluent, we consider.

11649. At present you have no further treatment in operation?—At present we have no further treatment in operation.

11650. But you are proposing to introduce a bacterial filter?—That is so, we are asking for the borrowing powers to go on with the works.

11651. Are you advised that the trade effluents mixed with your sewage will not prejudice the action of these filters?—That is what our engineer from his own experience, and our former engineer, advised was quite possible in the working of it. (*Mr. Walton.*) That is under certain conditions, sir, that the solids are taken out and the whole of the suds and treated for grease.

11652. Your opinion, Mr. Alderman Simpson, is that a local authority situated as yours is, may properly receive trade effluents into its sewers provided that manufacturers will carry out certain preliminary works?—(*Mr. Alderman Simpson.*) That is so, yes.

11653. And you have handed in certain printed conditions which you have attempted to lay down?—Yes, that is so.

11654. What is generally the nature of the conditions that you have attempted to lay down in Halifax?—Practically on the lines that Manchester has already adopted.

11655. That is to say, settlement of solids?—Settlement of solids, yes.

11656. Neutralisation?—That is so—neutralisation and settlement of solids.

11657. (*Sir Michael Foster.*) And extraction of grease?—And extraction of grease.

11658. (*Chairman.*) And regular flow?—And a regular flow; that is so, yes. Of course, extraction of grease, as I dare say you know, where a large quantity of it is done is now a very paying concern. In our immediate neighbourhood, one mill close to us makes no secret of it that they are now making £500 a year clear profit on effluent that used to go down the stream from the extraction of grease alone.

11659. Is that by means of ordinary seak tanks?—That is so.

11660. In these cases they simply withdraw the grease so far as it will pay to extract it; they are not the least particular to let go into the stream or the sewer quantities which do not pay them to extract?—That is so.

11661. (*Sir Michael Foster.*) But you are demanding complete extraction of grease?—(*Mr Walton.*) Well, not complete. (*Mr. Alderman Simpson.*) Yes, as far as possible, we are seeking, but we do not suppose we shall get that. (*Mr. Walton.*) We simply say all effluents shall be treated for the removal of grease.

11662. (*Chairman.*) How have your suggestions been received by the manufacturers in Halifax?—(*Mr. Alderman Simpson.*) They sent a fairly large deputation, and they did not receive the suggestions at all agreeably; however, I think since then, as they have seen that we were determined to go on, there is rather a better disposition to meet us, and I believe, a desire on the part of many of the manufacturers to put down such plant as we shall require. They passed a resolution. This is the wording of it:—

"Halifax Traders. Re Trade Effluent. Resolution passed at a meeting of the General Committee on the 14th May, 1902.

"That the conditions for admission of trade effluents into the sewers are not adapted to the industries within the Borough of Halifax, and are not in accordance with law, and that the traders, on the assessments of their factories being substantial contributors to the rates raised within the borough for the maintenance of the sewage system of the borough, any scheme which restricts the right of access from factories to such sewers

is unfair and unreasonable, and that a copy of this resolution be forwarded to the Town Clerk."

These are really their ideas that meet us, but I think that since then there is tacitly a better disposition to do something, and in private conversation with several of the manufacturers they think they have gone too far; they say they are prepared to meet us.

11663. (*Mr. Power.*) Do they all, or most of them, possess sufficient land to set up the preliminary works you would put on them?—No, sir; that is the evil; unfortunately they do not all possess that; that is the great difficulty.

11664. (*Sir Michael Foster.*) They maintain that they have the right to discharge their untreated effluent into your sewers?—They think so, yes; and the ground they take up for that is because those who are in the centre of the town had that right from all time, and their contribution to the rates, of course, is just the same.

11665. (*Professor Ramsay.*) What would the contribution from the rates from all the manufacturers be, compared to the total rates; could we get some idea of the fraction it would form; is it anything considerable?— (*Mr. Lord.*) It is considerable. (*Mr. Alderman Simpson.*) You might take it, it is very considerable, but I could not give you the figures they are.

11666. One-tenth?—(*Mr. Lord.*) Yes, at least.

11667. (*Chairman.*) Then in your case the absence of the preliminary works for the preparation of the effluent for the sewer does not really prevent your treatment; it simply makes it more costly?—(*Mr. Alderman Sampson.*) That is so; it simply makes it more costly to follow out.

11668. And many of these manufacturers have land upon which to carry out such?—Yes, on the stream they have.

11669. And you think there is a prospect now of your coming into some arrangement, at all events, with those who have land to carry out these preliminary works?—Yes, that is so.

11670. Would it be possible at all for a local authority situated as yours is to have separate trade sewers and separate treatment of trade effluents?—It would not be possible in our case. I think wherever it is possible it is a very advisable feature, and in conversation the other day our Borough Engineer made a statement that even though our mills are so scattered as they are in Halifax, it would pay us to put down separate sewers to treat the trade effluent apart from the domestic sewage. Of course it is rather a big order, that; I dare not say so. (*Mr. Lord.*) That is not taking it over the whole of them; that is taking those who are now discharging into the stream; these are practically all together, and I should think the discharge from seven or eight different manufactories is over 2,000,000 gallons. Well, to treat that if we had to take it in its crude state, it would pay us to take it in its crude state and treat it before we mixed it with our domestic sewage. There is one mill alone which turns out rather more than 500,000 gallons, which is rather a large quantity.

11671. (*Sir Michael Foster.*) You, yourself, would treat it and turn it into your sewers treated?—If we had to do it, it would be cheaper to do that than turning it into our domestic sewer.

11672. (*Chairman.*) Because they are contiguous to each other?—That is so, and when mixed up with domestic sewage it is much worse to treat than separately.

11673. (*Professor Ramsay.*) Are the effluents all of the same kind?—No, sir, they vary.

11674. Would they exercise particular influence on each other, some being acid and some alkaline?—Well, if they were turned in pretty equally, I do not think they would do much harm to each other, but when we get our bacterial beds it would greatly interfere with the working of them if we put them in with the domestic sewage, simply putting it through the ordinary settling tanks and then on to the beds.

11675. (*Chairman.*) Then, clearly, a regular flow would be of value to you, would it not?—Taking out the solids, that is so, sir.

11676. And if they would give you a regular flow, and not send it down flushing?—A regular flow. Take the case of the wire drawers; they turn down some 100 gallons of sulphuric acid and vitriol mixed, and you get that all at once; then you do not get any more for 24 hours from that particular works. If you watch the flow into the sewage works, it varies every 10 minutes or quarter of an hour.

11677. Then it is almost one of the elementary conditions which ought to be laid down, in your opinion, that you should have a regular flow?—Yes.

11678. You would have conditions to meet that?—Yes

11679. (*Sir Michael Foster.*) This is the great difficulty—the unequal flow, much more than any particular constituent of the trade effluent?—That is so.

11680. Beyond the solids?—Beyond the solids.

11681. It is the solids that trouble you?—The solids and the grease. Remove the solids and the grease and give us a continuous flow, and I think we could manage it then.

11682. (*Chairman.*) Now, Mr. Lord, take the case of one of those wire-drawers, the cost to the manufacturer of putting down a tank to receive these rushes of acid, and to dole them out through a pipe in equal volume spread over the 24 hours, would not be a serious matter?—£50 would cover it, sir.

11683. Therefore it would not be anything so ruinous?—Oh dear, no. On Saturday I practically came to terms with one of the manufacturers to put down a tank—a wire-drawer. I said if he would put down a tank sufficiently large to hold one day's flow, and I could fix the size of the pipe to his tank, if he would give me the maximum quantity of effluent per day, and if he would allow me to fix the size of the pipe, we would take it without treating it in any particular way. In that particular case it would do us more good than harm.

11684. (*Sir Michael Foster.*) Why do you good?—Well, the small amount of the acid would rather be to the benefit of the sewage than to the disadvantage.

11685. (*Chairman.*) May not the conditions you have tried to lay down have been too complicated, and frightened the manufacturers? Would not simple conditions that the solids be taken out, the grease removed, and a regular flow meet the case?—Practically the whole of the conditions are in clause 2; there is not anything serious besides that. You see we do not fix a hard and fast line; we simply say it shall not be injurious to the sewers or the sewage therein, that is the main thing. We had a chemical work which has been disused now some four or five years, and our main sewer down the bed of the stream is cast-iron; the chemicals and the vitriol from these works has eaten through the pipes. I have had to put in between 600 and 700 yards of new pipes this year. The life of an iron pipe ought to be much more than that. If that were put in in small quantities and mixed with domestic sewage it would not do any harm to the pipes.

11686. Then judging from what Mr. Alderman Simpson has said and your experience in that particular case you have just mentioned to us, there seems to be a prospect of your coming to some arrangement with the manufacturers of this district with regard to agreeing to certain conditions preliminary to the reception of their effluent?—I think so, sir; with several of them. With one or two of them I do not think we shall come to terms.

11687. (*Sir Michael Foster.*) And that is because they have no land, possibly; is that so?—Well, more, I think, because they have made up their mind that we should take it without it costing them anything; I think that is the main point.

11688. (*Mr. Power.*) The existing sewers are of a sufficient calibre to take this trade refuse, are they?—Our sewer is not sufficiently large to take the whole of it; but we are now asking for powers to increase the size. Our iron pipe is practically worn through. The sewer has been in some 32 or 33 years, and it is getting worn, and we are now seeking powers to put in a new main sewer, and that we are purposing to make large enough to take anything.

11689. (*Sir Michael Foster.*) Will that also be in the bed of the stream?—You cannot put it anywhere else in Halifax.

11690. (*Chairman.*) The ground slopes down?—The stream is in the centre; in the valley, between two large hills.

11691. (*Mr. Power.*) You would have to replace this sewer, whether you took the trade refuse or not?—That is so.

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11692. (*Chairman.*) You think it is prudent for a local authority as far as possible to foster trade in the neighbourhood, by giving facilities to manufacturers, provided they carry out these preliminary conditions?—(*Mr. Alderman Simpson.*) I think so, decidedly. I do not go so far as they do; they wanted to maintain that it was not in any sense of the term a residential town, Halifax, and that the residents out of business should not be catered for or thought of. They went so far as that anyone living in Halifax must be content to have all the smoke that could be poured out of the stacks and all the troubles that might arise from their bad effluents, practically. That is what they said in effect. We had a long argument on that point.

11693. Then, in regard to the position of the law on this matter, do you find that the law is clear on the subject of the responsibility of local authorities?—By no means; it wants a very considerable alteration there.

11694. Your difficulty at Halifax appears to arise from the fact that a certain prescriptive right has been obtained by these people of turning their effluents into the sewer?—That is so.

11695. But in cases of new manufacturers you have not the same difficulty, have you?—No; we could, in the case of any new manufacturer, of course, insist upon this code of rules being subscribed to.

11696. You can do that?—Oh, yes.

11697. The law permits you to do that?—(*Mr. Lord.*) We think so; but the millowners, on the other hand, think not, and there is the difficulty.

11698. It has been suggested to us by several witnesses—manufacturers—that the law ought to give to manufacturers greater powers than they now have to compel the local authority to receive their effluents. You probably, Mr. Alderman Simpson, do not agree with that?—We do not agree with that.

(*Mr. Alderman Simpson.*) There is a reason why. There are a certain number of tradesmen in Halifax who have to get rid of their refuse; we have no drains for that, and they have to cart it away at considerable expense, and they have to pay for the carting of it away, such as fishmongers, and butchers from the slaughterhouses; all their offal has to be carried a considerable distance and buried. We have no destructor at the present time, and I think perhaps our system of burying it is as good as any of the newer ideas with regard to destructors; but at the same time, they have to pay for the removal of this trade refuse, and therefore it is only fair, if one section has to pay for the removal of it, that the manufacturers should either be charged something for the treatment of their effluent where it becomes a large question, or, at all events, contribute something more towards the rates.

11699. Then do you think that any alteration of the law in these matters is required, so as to give powers to local authorities to insist upon the carrying out of preliminary works?—Oh, decidedly.

11700. Can your town clerk suggest the nature of the alterations required in the law?—(*Mr. Walton.*) I quite agree with the suggestion of a central authority, and that a central authority would be preferable to a court of law. There would be more uniformity of practice; we should know what to expect, and so would the millowners.

11701. Then what central authority do you think would be the best for the purpose, the ordinary courts of law to which appeal should be allowed, or some special authority, say a Rivers Board sitting in London?—A special authority; not a court of law by any means.

11702. You would prefer to appeal to a special rivers authority, if one were in existence?—Certainly.

11703. Would the Rivers Board as a court of first appeal be of any use to you?—Well, personally, I should not object to the Rivers Board.

(*Mr. Alderman Simpson.*) I think it is a very proper court for the purpose. I have said so all along; with our manufacturers as burgesses we cannot deal, perhaps, as severely as we ought to, but when they are in the hands of the Rivers Board there is more foreign element, and consequently they have to conform.

11704. (*Professor Ramsay.*) Have you any alkali works in your district, or works under the Alkali Act?—I do not think so; no, I think not, sir; we had at one time, but they are now closed.

11705. (*Chairman.*) Then do you think that manufacturers should be required to pay a special rate or charge in those cases where they are allowed to connect with the sewers?—Yes, certainly.

11706. You do not think that their contribution to the rates, they being generally large contributors, is a sufficient charge?—It is not, because there are large manufacturers who practically turn no effluent out, and others who turn out a very considerable proportion. It is not fair that both should be rated alike in that case.

11707. (*Mr. Power.*) Then would you rate the manufacturers that do submit to the preliminary treatment that you enjoin; would you rate them as well as make them do that?—Yes; the idea would be to get at their daily outfall and the nature of it. We have our own chemist, so that we should easily get to know what their effluent is, and a charge would be made to them in such cases where they have no opportunity whatever to put down tanks or have preliminary treatment of their own.

11708. (*Sir Michael Foster.*) You would charge them for the extra expense to which you are put above that to which you are subjected in the ordinary sewage?—Yes, that is it; that is what we propose.

11709. (*Chairman.*) You think the law ought to be modified to permit you to enforce that?—We do.

11710. Your sewage works are how far from the centre of your town?—One and a half miles.

11711. Then riparian rights do not play any important part in this discussion at Halifax?—No; they do not.

11712. Because you so readily turn the flow from your sewage, after treatment, into the river again?—That is so.

11713. But you can conceive of cases, and, probably, you have personal knowledge of cases where manufacturers draw from a stream, and where their turning their effluent into the sewers might seriously interfere with riparian rights?—I can quite understand that. There is another element that I think, perhaps, you have not touched on there, where the corporation might take some consideration, and that is where manufacturers have sunk a deep well. They are no longer customers of ours for water, and something ought to be taken into account there; they are independent of the Corporation for their water supply, and yet they are wanting to put their effluent into the drains. Now, if they are paying so much a thousand gallons for water, and it has gone through its various processes, and is no longer of any use, and they put it into our drains, there is some reason there in taking it, you can understand, because they have already paid the Corporation for the water that they have used, but there is a disposition now on the part of many of our manufacturers and brewers and others to sink deep wells. There is one just been sunk, I went to see it the other day, down to 595 feet, or below sea level.

11714. That is because they obtain water probably cheaper?—That is the idea, that they do, but we charge a low price for our water.

11715. That only affects the question of the amount of the contribution that they might be called upon to pay?—That is so.

11716. (*Sir Michael Foster.*) You would make a reduction in favour of those who took your water?—Yes.

11717. (*Chairman.*) Because they are good customers?—Yes, certainly.

11718. I might ask your opinion about manufacturers who draw water from the stream, and are bound to return water to the stream, do you think they ought to be compelled to purify the effluent themselves?—Distinctly so, yes.

11719. Is there any point, in connection with either the condition of the law, or conditions that might be laid down for effluents that are turned into sewers, that you would like to bring before us that have not been touched upon?—(*Mr. Walton.*) I think the central authority ought to combine all those things.

11720. You think the main thing required is that there should be a suitable appeal authority?—Yes; I

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think the manufacturers would be quite willing to pay something, the question is the amount, and that central authority, after hearing the circumstances of each case, would have to fix it.

11721. It has been suggested to us by some witnesses that the law is not clear enough, and ought to be defined to meet all these cases. Do you think it practicable that legislation should be made to apply to all these cases; must not many of them be treated on their own merits?—You could not lay down a hard and fast line which would operate in all cases, alike in Halifax; each case would have to be dealt with separately.

11722. Then, in your opinion, the main thing is to have a suitable appeal authority to settle where the difficulty arises between manufacturers and the local authority?—I think that is very important indeed.

11723. (*Sir Michael Foster.*) But you would admit the general principle laid down by Mr. Alderman Simpson, that where the effluent threw an extra expense upon the sewage there must be some contribution?—Yes.

11724. The central tribunal, then, would only determine how much that contribution should be?—Exactly. The manufacturers are quite of the same opinion; they are quite willing to pay something; the question is now much.

11725. (*Professor Ramsay.*) They do not think that any restriction would ruin their trade, do they?—Well, they practically at first said that these regulations would drive trade out of Halifax, which is perfectly absurd.

11726. (*Sir Michael Foster.*) That would be the point that would be brought before the central tribunal, whether the demand of the sewage authorities was such as to injure the trade?—Exactly.

11727. (*Mr. Power.*) These particular regulations would drive trade out of Halifax, did they say?—Oh! dear, no: these are based upon regulations which are enforced in very important boroughs and towns, both in Lancashire and Yorkshire, and they have had no such effect. From replies which we have received from these places, they have been practically cheerfully agreed with.

11728. (*Dr. Burn Russell.*) These regulations are an attempt to get, by voluntary agreement, some conditions out of the manufacturers?—Yes.

11729. Is there not some element of established law in some of those regulations; No. 2, for instance, the detail, seems to suggest the provisoes of Section 7 of the Rivers Pollution Prevention Act, a little expanded, perhaps?—I think the No. 2 Regulation is not at all inconsistent with Section 7 of the Rivers Pollution Prevention Act, but rather gives a discretion to the Corporation than otherwise, and allows them to relax the strict conditions of Section 7.

11730. You would probably like to have powers to make such regulations in the way of bye-laws, or something of the sort?—Yes, subject to the sanction of the central authority.

11731. (*Chairman.*) That is a modification in the law that you would advise, is it?—Certainly.

11732. (*Sir Michael Foster.*) I rather gathered that your greatest difficulty is with those manufacturers, who have, what they think, old rights in your town?—(*Mr. Alderman Simpson.*) Yes, that is so. (*Mr. Walton.*) Well, the greatest difficulty really, I think, if you will excuse me, is with the manufacturers on the stream; they are the largest users of water, and they take very largely from the brook pure water, and they want now to discharge it, in its filthy state, into our sewers.

11733. Yes; but the difficulty in coming to terms lies chiefly, does it not, with those who say they have always had the right to discharge into the sewers, and they do not see now why they should be called upon to pay for that which always has been their right?—(*Mr. Alderman Simpson.*) That is so. We have large dyers right in the centre of the town, and at the farthest parts of the town, away long distances from the stream. These people object altogether to these regulations; they say they have had the right ever since their mills were built, and they do not see why we should wish to interfere with them. I put this question to them the other day: "Would you allow us to send our chemist to take an analysis of your trade effluent?" and one of the dyers' representatives said: "Oh! by no means." "Well, why would you not?" "Because," he said, "we have trade secrets, and we would not like to see your man; we do not know who your man is; we would not like to see him coming into our place to get at our trade secrets. So important is that, that recently a man applied to us as a fireman, and was put on, and we find now that he has been serving in that capacity practically in disguise; he has learned our secret, and he has left us now."

11734. (*Chairman.*) Then, with regard to these manufacturers on the stream, surely that difficulty ought not to be great, because they have no prescriptive rights; they are not now connected with your sewers, and they are, under pressure of the Rivers Board, to carry out purification works which will be considerably more expensive than the works you are asking them to construct?—Yes.

11735. Then, what is your difficulty with them?—I do not anticipate any difficulty with them. (*Mr. Walton.*) The next step they intend to take is to call upon the Corporation for their permission to discharge into the sewers. The Corporation will refuse it; they make an application to the County Court judge, and the band then will begin to play.

11736. Surely, when you say you will refuse it, you will refuse it when your conditions are not carried out?—Exactly, but they say our conditions are unworkable. able.

11737. (*Mr. Power.*) But the conditions the riparian authorities might put on them might be worse than yours?—Precisely; the riparian difficulty is a very great difficulty to my mind, because they take the water at low mills, and they take a vast quantity of water out; if that is turned into our sewers, I know one water-wheel will have to stop entirely. They will have to settle that question amongst themselves.

11738. (*Chairman.*) If they turn into the sewers the cost of their purification is so greatly less than if they have to satisfy the Rivers Board before turning into the stream, that I should have anticipated that these people would have very readily complied with your conditions. Where does the difficulty arise?—It is to their interest to settle with the Corporation; it is the easiest way of getting out of it.

11739. Then why do they not?—I do not think there is so much unwillingness on their part now as there was a month ago.

11740. Probably, additional pressure by the Rivers Board would help matters on, would it not?—(*Mr. Alderman Simpson.*) Oh, yes, it would.

11741. Then, speaking generally, you recognise the great importance, connected, as you are, with a large town, of purifying the stream as far as possible?—I do.

11742. You think it is a great public duty, and that efforts should be made to carry it out?—I do. I thoroughly agree with that. Of course, we have people living now who say they remember fishing on the streams there. They are now foul, polluted, turbid streams.

11743. Then the condition of things has arisen owing to people being allowed one and the other to connect up with the sewer and the stream in this way, without purification works, but, in regard to the new manufacturers, that is not likely, in your town at least, to arise?—No, I hope not.

11744. So that there will be no expansion of the evil?—No. We shall try to limit it now to the utmost that we possibly can.

11745. (*Dr. Burn Russell.*) Are the Rivers Board exercising pressure upon your Corporation at the same time as upon those manufacturers?—Yes, they are, sir. (*Mr. Lord.*) Well, we have spent £50,000 this last 18 months, and we purpose spending another £50,000 within the next 18 months.

11746. They wish to simply shake off the Rivers Board by transferring their obligations to you without conditions?—(*Mr. Alderman Simpson.*) That is what they want to do.

11747. That is in plain language what they want to do; that is their game?—That is really what they want to do. It would only make one authority then for them to look after, instead of a considerable number.

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11748. The trade effluents—you have several; they all differ in their character, at least there is a considerable variety?—Yes.

11749. And your suggestion was to throw them together and deal with them?—That is one suggestion made by the borough engineer.

11750. But, following the idea of simplifying the ultimate problem by excluding the trade refuse from your sewers, you might find that it would be further simplified by dealing with these effluents separately in some cases. There must be some effluents that made the total very difficult to deal with?—Well, one can quite conceive that. (*Mr. Lord.*) That is my idea in saying that it would be better to treat the trade effluents separately, rather than mix them with the domestic sewage, because it would be better to deal with 2,000,000 gallons of bad sewage than make it into 5,000,000 gallons of sewage practically as difficult to deal with.

11751. Then, following the same idea, if you were tackling the question practically, you might find that some individual effluent of the total trade effluents might be with advantage dealt with separately, rather than throwing it into one witches' cauldron?—(*Mr. Alderman Simpson.*) That is so.

Mr. J. Jones.

Mr. Joseph Jones, called in; and Examined.

11752. (*Chairman.*) You are the borough surveyor of Pudsey?—Yes, sir.

11753. Your borough has been recently incorporated?—Yes, sir.

11754. What is the population?—Close on 15,000.

11755. And what is the manufacture carried on in your neighbourhood mostly?—Mostly wool and dyeworks, wool-washing and cloth-washing, dyeworks, gasworks and tanneries.

11756. And are the effluents that are poured out in your neighbourhood by the manufacturers mostly of one kind, or have you a great variety?—There is a variety, as the trades differ, that is all.

11757. But you have not a great variety of trades, have you; they are mostly connected with the woollen industry?—Yes, excepting the tanneries and the gasworks.

11758. (*Sir Michael Foster.*) The tanneries, are they extensive?—The largest one is that of the Chairman of our Sanitary Committee—Alderman Goodall's.

11759. (*Chairman.*) Then, until quite recently, not only did no manufacturer treat his effluent, but the authority at Pudsey did not treat its domestic sewage?—That is so, sir.

11760. The treatment of the sewage at Pudsey is quite recent?—Yes.

11761. How long has it been at work?—Two years nearly; some part of it four years, but the bulk of it two years.

11762. I believe that the action that has been taken has been due to the pressure of the Rivers Board?—No doubt.

11763. And what is the nature of the treatment at Pudsey?—We have the Smalewell works; that is the smaller works where we treat it with lime. We did treat it with alumino ferric, but after we got one manufacturer on we had to change and take the lime, because the effluent was so acid.

11764. Then what is the second process?—At Hough Side we have treated with alumino ferric all the time, but we want to get on the septic system; that is what we are trying for now.

11765. But what I meant to ask you was, after settlement have you a further process?—Oh, yes, after settlement in the tanks we run it through filters.

11766. What kind of filters?—Artificial, of course, composed of sand, stone, and ashes.

11767. Are they contact beds or continuous filters?—Continuous filters; but they are so constructed that we can use them for contact beds if we wish to—we have valves.

11768. Do you spread the sewage upon the surface like a rain, and let it continuously drop through?—No, we do not; we simply carry it with wooden spouts.

11769. It runs continuously through?—Yes, sir.

11770. Do you find that effective?—Well, we do not find it up to the mark, I must say.

11771. Are you satisfying the Rivers Board?—We did when we were using alumino ferric, but now we have tried this experiment, we find it is not what it should be, but, of course, when we used about £5 10s. worth of chemicals to 1,000,000 gallons, we had no complaint from the Rivers Board whatever.

11772. Did you for a short time work your works with domestic sewage only?—No, only the smaller works.

11773. From the very beginning you had this admixture of trade refuse?—Yes, sir.

11774. You had sewers, I suppose, before this pressure of the Rivers Board came?—No, our sewers are as late as 1894, the sanction for the scheme was in 1894.

11775. So that the sewering of the district is also comparatively new?—Yes.

11776. From the beginning you have apparently been willing to receive trade effluent?—That is so, if they (the manufacturers) did what the Committee wished them to do.

11777. You laid down certain conditions?—Yes, sir.

11778. Speaking generally, what are they?—The Sewage Committee asked them to put down tanks in duplicate so that they can have one half day's supply; those tanks are to discharge on to the filters.

11779. What is the object of the tanks?—The object of the tanks is so that they can settle the solids and run them on to a sludge filter, and they have to have a filter for the effluent and we only allow them to connect to our sewer from the filter, not from the tanks.

11780. Have the manufacturers in your district generally, complied with the conditions which you have laid down?—They have, sir.

11781. You have had no difficulty in getting them to comply?—Very little. Of course, we have four manufacturers not yet connected to our sewers, but that has been because they have not had the sewers near the works.

11782. (*Sir Michael Foster.*) You have two sewage works?—Yes.

11783. One at Hough Side and one at Smalewell?—Yes, sir.

11784. And at Smalewell the manufacturers' refuse is $\frac{7}{8}$ths. of the whole sewage?—Yes, but one reason is that we have not all the domestic sewage running yet to the new works.

11785. That ratio will be changed presently?—Yes, but not to a large extent, only about 3,000 population will be connected to the Smalewell works when all is on.

11786. So the Smalewell works are practically for the treatment of trade effluent?—A trade effluent practically.

11787. And will be so?—Yes, sir.

11788. (*Chairman.*) Do you think, speaking generally, that it is desirable to deal with trade effluents by means of a separate sewer and separate treatment?—I think not, sir: I speak for Pudsey. It would be a very expensive piece of business.

11789. You think that in your district the effluents are of such a character as not to prejudice the treatment of the sewage, provided that certain conditions are carried out by the manufacturers?—I think so. If we had to compel a separate system of sewage the distance between the manufactories is so great it would be very expensive, and I think if they would put down preliminary treatment works, as requested by the Sewage Committee, the Council ought to take them.

11790. (*Sir Michael Foster.*) Which of your works is most effective, the Hough Side or the Smalewell?—The Hough Side works will be the most effective, because we are satisfied we can turn out an effluent to satisfy the Rivers Board, for we have land as well as the artificial filter, but the land is not prepared.

11791. (*Chairman.*) You have no anxiety about bringing about good results in the future, when your works are completed?—I have not.

11792. You think the final passage over the land will meet the case?—I do.

11792*. Even with all this trade refuse?—Yes.

11793. (*Professor Ramsay.*) Of what character is the trade refuse?—Wool-washing and scouring.

11794. (*Chairman.*) Is there much grease?—Yes, and that is the reason the Committee ask them to provide tanks and filters; if they send grease on to the filters it will clog them, therefore it makes the manufacturers do something themselves, and if it will run through the filters of course we are quite willing to treat it.

11795. Your experience, of course, has not been a long one at Pudsey, but you think that the reception of these effluents into your sewers will not prevent you from carrying out your duties to the community as insisted upon by the Rivers Board?—I feel satisfied, and so do the Sewage Committee.

11796. And you think generally the authority is wise in promoting trade in the district and putting no difficulties in their way?—I do.

11797. And you think the conditions that you have laid down are such as can be carried out by the manufacturers without a ruinous cost?—I think so.

11798. You think they are thoroughly practical?—I think so.

11799. (*Professor Ramsay.*) They also think so?—After they have got the works down they are quite satisfied. At the beginning, of course, they did not like to do it, but I pointed out to them that it was really necessary, otherwise we should have the works clogged up and no end of sewage deposited there. After they had got the works down, one of them said to me that they were satisfied the thing was right.

11800. (*Chairman.*) Then in this case there is this facility, is there not, that if they do not do these things to satisfy you they had to carry out more important works to satisfy the Rivers Board?—Those were the last words almost to a manufacturer: "If you do not like to do this, satisfy the Rivers Board." That was always my last word, and I think that was the paying word.

11801. Do you think that the condition of the law in regard to the reception of trade effluents by local authorities into their sewers is sufficiently clear?—I do not, sir. I find it very difficult to interpret. My experience is, that whenever the subject of trade refuse treatment comes before my sewerage committee, there is great difficulty in defining, and, therefore, applying the law.

11802. But do you think that it would be possible to make the law so clear as to apply to all cases?—I think so, if you note what I say there in reply to that question. I think if you have it definitely stated by a local authority what they shall do, and only be allowed to be connected with our sewers so long as they do that, I think every local authority will be safe. I think the law should demand that.

11803. Do you think it is possible to lay down general lines by legislation which will apply to all cases?—I think so, if they give the local authority power so to do or to refuse.

11804. You think clearly that the local authority ought to be empowered to make conditions?—I do most certainly.

11805. Do you think that a manufacturer has a right to ask for legislation to give him greater powers than he has at present to force a local authority to receive effluents?—He may think so, but if a manufacturer had all his own way he would not do much, that is evident.

11806. Quite clearly there ought to be, in your opinion, safeguards to the authority, so as to permit them to make bye-laws and conditions?—Certainly.

11807. They should not be compelled to receive it without conditions?—No, far from it.

11808. You have found that the manufacturers in your district were generally willing to adopt the means to partly purify the effluent before sending it into your sewers?—That is so, sir. There is only one person that we really had to threaten that we would not take him in on any account, because he would not provide works that we asked for, but when he found that he had to satisfy the Rivers Board, then he came to.

11809. As this is necessarily a matter to be discussed between the local authority and the manufacturers you think it is necessary, do you not, to have the power of appeal to someone besides the local authority?—Oh, I am quite satisfied of that, sir.

11810. Then what body would you suggest for appealing to, an ordinary court of law?—No.

11811. Not a court of law?—No; the Rivers Board most certainly.

11812. You would appeal in the first instance to the Rivers Board?—Certainly.

11813. Do you think there should be any further appeal from the Rivers Board to any central authority?—I do not think so. Why should there? The Rivers Board is composed of men who know what they are talking about in those matters, and mostly practical men in that trade; and they are not liable to be influenced by local prejudice as the ordinary local authority is.

11814. If there were in London a central authority to deal with these questions connected with rivers, do you think that that would be a suitable body to appeal to finally?—I think myself that the West Riding Rivers Board ought to be the final.

11815. In your district?—In my district.

11816. Then your opinion clearly is that an appeal to the Rivers Board is sufficient in your case?—I do.

11817. Ought manufacturers, in your opinion, to contribute towards the additional cost to which local authorities are put in dealing with trade effluents?—No; I do not think so.

11818. You think their ordinary contributions as ratepayers would suffice?—I think so, after they have provided what we ask them to do, because they bring work into the district, they provide livelihoods for hundreds of people. Why should they be embarrassed? I think reason ought to dictate.

11819. Tell me, in your district what is the water supply of these manufacturers? Do they draw from wells or from your own water supply, or from the river, or how?—Both wells and our town's supply.

11820. And also from the stream?—Where they can get it, of course.

11821. In that case difficulties do not arise, do they, from manufacturers being compelled to return to the stream water which they have taken from the stream?—No; I think you will agree with me, because you know the place, that any sewage taken from any manufacturer into our sewers gets back again before anyone requires it.

11822. Then in your case those difficulties do not arise?—They do not.

11823. But you know that in other cases they do in fact arise?—They do; yes.

11824. And that in such cases often, if they were allowed to turn the effluent into the sewers, there would be no stream left?—There would be no stream left.

11825. If you took water out of a stream and turned it into a sewer, whereby it did not come into the stream lower down, there would be for a certain length no stream left?—Yes; but the reason I say that the riparian owners should not apply there is this: When the manufacturers are asked by a sanitary authority to provide and do certain things, and they compel them, as the Rivers Board would compel them, to purify their sewage ere it be taken into sewers, then I think myself if they are requested to put into the town's sewers they really ought to be exempt. I do not see why they should not. Compulsion on both sides ought not to apply.

11826. (*Dr. Burn Russell.*) How long did you say that Pudsey has been constituted as a borough?—Two years, sir.

11827. So that you have had an opportunity of bargaining with manufacturers who are actually putting their discharge into the stream direct?—Yes, sir. I have been there all the time; I was there before the manufacturers were connected to our sewers, and so I have had the arrangements with them.

11828. I see you give the exact figures as to the proportion of domestic to manufacturing sewage in your borough in your statement, but I do not think you have been asked in evidence to give it?—I was simply asked what kind I have.

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11829. You might just tell us the total volume of sewage at each of these works, and what the amount of the manufacturing refuse is?—At the Hough Side Works it is 238,000 gallons per day total flow, and 90,000 gallons of it is from the manufacturers. That is from actual figures from the manufacturers, because before these works were commenced I sent a note to all the manufacturers in the district, asking them how many gallons of trade refuse they discharged per day. Of course, if they told me the truth, well and good; the replies came to that effect.

11830. (*Chairman.*) About one-third?—Yes.

11831. Then at the other works, Smalewell, what is the respective volume?—At Smalewell the total volume of sewage discharged is about 84,000 gallons per day, and the volume of manufacturers' effluent about 72,000 gallons.

11832. Almost wholly manufacturers' effluent?—Very nearly, sir.

11833. Have you carried out any experiments to see if the treatment of the effluent was facilitated by the admixture of sewage?—No; I do not think we have done that.

11834. (*Sir Michael Foster.*) Your treatment at Hough Side and Smalewell is the same, except that at Hough Side you have land?—After the same process, practically.

11835. You treat it in each case with lime?—No; The sewage at Smalewell Works is very acid, and therefore it requires lime; at the other, of course, we use alumino-ferric.

11836. Alumino-ferric and afterwards a filter?—Yes.

11837. And you are prepared, subsequently, to throw it on to land?—Yes; we have about 25 acres of land, or will have.

11838. (*Chairman.*) How near do you attain the provisional standard of the Rivers Board?—They have taken the test, but they never told us; therefore, I do not know; I could not answer that question.

11839. But is your final effluent at present fairly good?—Just now, you see, we are not using alumino ferric.

11840. (*Sir Michael Foster.*) But you are using it still at Hough Side, are you not?—No; we are trying to work without it at Hough Side.

11841. (*Chairman.*) To reduce cost?—No, not exactly that; simply our doctor wished to try an experiment.

11842. Then, what is the alternative you are trying?—Simply to run it through and get it under septic action.

11843. You are trying the effect of a septic tank?—Yes.

11844. How long has that been at work?—Most of the winter.

11845. (*Sir Michael Foster.*) How big is your septic tank; how much does it hold?—Oh, we have nine of them; 68,000 gallons each.

11846. (*Chairman.*) But do they hold a day's flow?—Well, oh, yes; they hold more than a day's flow—nine 68,000 gallons.

11847. They have hardly developed septic action yet, have they?—Only the first tank partly.

11848. (*Dr. Burn Russell.*) What stream do you drain into?—It is called Pudsey Beck; it goes into the Aire.

11849. And what condition is it in when it reaches you, Pudsey Beck?—It is not what it ought to be.

11850. (*Chairman.*) When it reaches you there are other polluters higher up?—I think myself, that Tong does not do more than it ought to do.

11851. But you do not improve it?—We do not make it worse than Tong, at all events.

11852. You mean you do not make it worse since you treat your sewage; you did before?—Just so.

11853. And all that passes into the Aire, and by means of the Aire through the city of Leeds?—Yes. We feel satisfied we shall be able to treat our sewage without complaint.

11854-55. (*Dr. Burn Russell.*) Are the Rivers Board pressing you much as a borough?—I have nothing really to complain of of the Rivers Board. If they take a sample, if it is not what it should be, they drop a note to tell us so.

11856. (*Chairman.*) But the work you have done has been in consequence of their pressure?—That is so, and the work we have done is so far satisfactory to them; they are ideal works, so far as they go.

11857. We are glad to hear that you are intending to carry it still further?—Oh, that is so, we intend to satisfy the Rivers Board.

11858. The interest of your evidence seems to me to lie in this, that you are prepared to assist manufacturers by receiving their trade effluent, if they carry out certain conditions, and if you find it practicable, then to treat the sewage and to bring about satisfactory results?—That is so, sir.

11859. And you think their contributions in a direct way are sufficient without calling upon them to pay any special rates?—Yes, and if they provide preliminary works, as requested by the authority, I think it is quite sufficient.

11860. (*Sir Michael Foster.*) Do your filters cost them much? You insist on each of them having filters as well as settling tanks?—No; it depends how the land is situated. In some places they do not need to have walled filters at all, the earth excavated and then filled in with stone and cinders and coke is quite sufficient.

11861. But you insist on the filters, do you not, in order to purify their effluent beyond the mere settling?—Yes; we do not allow them to connect up from the tanks, they have to run from the tanks on to filters, and we only have them connected up to our sewers from their filters; in no case will we allow them to be connected with the tank for this reason; if they connect up to the tanks anyone can go at night-time and open the valve, and away the whole lot goes. That cannot be done with the filter.

11862. (*Dr. Burn Russell.*) Have you any manufacturers who absolutely have no ground on which to put any sort of works, tanks, or otherwise?—We have had several, but they could buy land suited for the purpose.

11863. They are in a position where they can buy land?—They have been in our district.

11864. And you take such steps as ultimately compel?—We said, "Either satisfy us, or you can satisfy the Rivers Board; you can please yourselves which."

11865. (*Sir Michael Foster.*) What kind of filters are they? You have not told us what kind of filters you insist upon for the manufacturers' refuse?—We are not particular, sir, whether they put all engine ashes rougher at the bottom, finer at the top, or they put it partly stone and partly ashes or coke. Of course, the gasworks put all coke.

11866. (*Chairman.*) What are you aiming at with these filters in the factory?—You are aware if there is nothing but tanks they will let grease go in; that grease, of course, will get into our works and injure them, but if it has to discharge on to filters it will clog them up.

11867. It is a safeguard?—It is only a safeguard; we want them to take the rougher solids out.

11868. You do not know whether a filter does any good, but you say a filter; you know it cannot pass through a filter without the grease is withdrawn?—That is so.

11869. Incidentally, I suppose the object of the filter is to remove still more the solids suspended?—That is so; but you see, suppose they had a capacity for tanks, and without filters they could simply go in the night-time, stir the thing up, and away the whole lot goes. That cannot be done with the filter; that was our point.

11870. (*Sir Michael Foster.*) Did their filters get blocked?—Yes, they have, and they have to replace the ashes.

11871. (*Chairman.*) That makes them careful?—That makes them careful. Of course, we are not better than we ought to be sometimes. There was one manufacturer had it to clean rather oftener than he liked, so he cleared one corner of the filter, to let the liquid have a freer course.

11872. It ran straight through?—Yes.

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11873. Then you find inspection to be absolutely necessary?—Oh, yes, they must be inspected from time to time, otherwise they go wrong.

11874. (*Professor Ramsay.*) Do they not object?—Oh, I have not found one yet objecting. As soon as ever they do not do what I want, our town clerk has to make that definite; we only allow them to be connected up to our sewers, so long as they send it in satisfactorily. If they refuse me going on to their works, we cut them off.

11875. (*Sir Michael Foster.*) Then they would be under the Rivers Board?—And then they must deal with the Rivers Board.

11876. (*Chairman.*) I think we need not detain you longer. We are obliged to you for coming and giving us your interesting evidence?—Thank you, sir.

Mr. W. Hopkinson, called; and Examined.

Mr. W. Hopkinson

11877. (*Chairman.*) You are the Borough Surveyor of Keighley?—Yes, sir.

11878. What is the population of your borough?—About 42,000 at present; 41,000 odd last census.

11879. And what is generally the business carried on there?—The staple trade is the worsted spinning, but we have a great amount of iron work and wool-combing.

11880. Then the worsted spinners and the iron works will turn out little or no trade effluent?—Not very much from the spinning or the iron works.

11881. So that the trade refuse with which you have to deal in Keighley is mainly from the wool-combings?—Wool-combings, yes.

11882. (*Sir Michael Foster.*) But you have tanners' refuse also?—Yes, we have tanners' refuse also.

11883. No very large quantity?—No very large quantity; three or four tanners, but not on a very large scale.

11884. (*Chairman.*) Do you admit tanners' refuse into your sewers?—Yes.

11885. How long has that been your rule?—Since 1893.

11886. Was that at the time of the establishment of your sewage works?—Yes.

11887. And have you found any inconvenience from the admixture of trade refuse with your sewage?—At first we did, on account of the wool-combers' suds not having been treated.

11888. Can you give us some idea of the relative volume at present of your domestic sewage and the trade effluents in your borough?—About 20 per cent. is trade refuse.

11889. And that is mainly?—Wool-combers' suds, and there is a little dye water, and there are the tanners.

11890. In receiving effluents into your sewers, do you insist first of all upon any preliminary treatment?—Yes.

11891. (*Sir Michael Foster.*) You have done always?—Well, we did not get the powers till 1898, but prior to that we asked them to do a little.

11892. (*Chairman.*) What you would ask them to do would be mainly the withdrawal of grease, would it?—Yes.

11893. Then do you find the manufacturers have complied with these conditions?—They have never raised any objections.

11894. They have not raised objections?—No.

11895. They have found it quite practicable to satisfy your conditions?—Yes.

11896. What is your system of sewage?—Intermittent downward filtration.

11897. (*Sir Michael Foster.*) With what kind of land? Well, it is very good land; you might really say virgin soil; there is part gravel.

11898. (*Chairman.*) Do you carry out any first process to separate solids?—No.

11898*. Direct on to the land?—Yes.

11899. (*Sir Michael Foster.*) You discharge crude sewage, I take it, on to the land?—There is a small tank to catch broken pots.

11900. What acreage of land have you under treatment?—Under treatment 50 acres, 62 including roads and banks.

11901. And other land available, if required?—And other land available if necessary.

11902. (*Chairman.*) To what extent are your manufactories connected with sewers; is that general or exceptional?—General.

11903. Have you made any conditions as to there being a regular flow?—No. We have conditions, but we have not enforced them.

11904. You have not found it necessary to enforce them?—We have not found it necessary.

11905. The effluent from which most of the grease has been withdrawn, mixed with your sewage, has not prejudiced your treatment on land?—None whatever.

11906. You are producing results which satisfy the Rivers Board?—Yes, it is very rarely we have a complaint from the Rivers Board.

11907. (*Professor Ramsay.*) Do you know if it pays the manufacturers to extract grease?—At the present moment it does; two or three years ago it did not.

11908. (*Chairman.*) And when they did not it went largely towards the cost, though, did it not?—Oh, yes.

11909. You have not found it desirable to take the effluents into a separate trade sewer?—No, the quantity is not large enough for us to do that.

11910. Do you think that authorities ought to have powers for he construction of separate trade sewers?—Well, that is rather a difficult problem. If you get the whole of the trade refuse mixed together, probably it would be as difficult to deal with separately as it would be if it were mixed with the domestic sewage.

11911. Speakng generally, you think the admixture with the domestic sewage is the better plan?—So far as Keighley is concerned, I say so.

11912. But have you powers at present to create a special sewer to connect a manufacturer with your main drainage; have you powers now?—No, we have not.

11913. Then would it, in your opinion, be advisable that powers should be given to authorities to construct a sewer to take trade effluents, at all events, to that extent?—I think it would if it could be definitely settled that they could treat the whole of the manufacturers' refuse separately from the domestic; it probably would be advisable.

11914. But you have not at present powers. You see, if you have a manufacturer a little distance from your sewer, you cannot, with your present powers, construct a sewer to bring his effluent into your sewer?—No, but he has power to come to our sewer, I think.

11915. (*Professor Ramsay.*) You do not think it necessary to have further powers?—I do not think it necessary; I think our powers are sufficient for that.

11916. He might construct sewers?—He might construct his own private drains connecting to our sewers.

11917. (*Chairman.*) If he had to cross a road?—Powers might be given him.

11918. There is no necessity to alter the law?—No, there is no necessity to alter the law; we would grant permission to cross any road.

11919. Are the positions and rights of the manufacturers and local authorities under the existing law clearly defined, in your opinion? Perhaps you think that might be a legal point?—I gave my answer before that I thought it was a legal question.

11920. (*Sir Michael Foster.*) Have you any experience on the matter?—No, I have not.

11921. (*Chairman.*) You have had no difficulty in your district between the local authority and the manufacturers?—None whatever.

11922. You said to the manufacturer: "If you do certain things we will take it"?—Yes.

11923. And your experience is that he has not ruined his business?—Not at all; it is at the present moment to his advantage to do it.

11924. (*Professor Ramsay.*) Are the manufacturers in your district large ratepayers?—Yes, they are.

Mr. W. Hopkinson.

3 June 1902.

11925. (*Sir Michael Foster.*) Where do they take their water from—the stream?—No, from the Corporation water supply, excepting in one case.

11926. (*Chairman.*) Therefore they may turn into your sewers without interfering with any riparian rights?—Yes.

11927. Do you think that manufacturers connected with sewers in that way ought to pay a special rate, so as to compensate the local authority for the cost of treating their trade effluent?—Not if they treat it preliminarily, I do not think so. As large ratepayers, I think they ought to have consideration shown them.

11928. (*Sir Michael Foster.*) You demand such treatment so that really you are able to treat their trade refuse together with the rest of your sewage?—Yes.

11929. And you are not put to any expense in order to treat their trade refuse?—I do not think we are put to any expense whatever.

11930. Do the manufacturers do anything to their sewage before passing it on to your sewers?—No, only by passing it through filters to take out the solids.

11931. Through filters?—Through filters.

11932. (*Chairman.*) To remove solids?—Through filters to remove solids; the colouring matters they cannot take out.

11933. You think the conditions to be laid down by local authorities should consist of withdrawal of solids and of grease?—Yes.

11934. And probably to some extent regularising the flow, so that it should not come in rushes?—Yes.

11935. (*Sir Michael Foster.*) There is a good deal of colour in the trade refuse which comes to you?—Yes, there is a certain amount of colour.

11936. But that does not make any trouble to you, because you are using the land system?—The only time I have noticed colouring coming from effluent is when there has been an exceptional amount of dye water, and then it was slightly discoloured.

11937. That is in your effluent from the land, slightly discoloured?—Yes.

11938. (*Chairman.*) You have no cases in your district, but you know of cases where the local authorities have refused to take effluent because of the prejudice to the treatment of their sewage?—Yes.

11939. And do you think, therefore, that there ought to be any general legislation compelling authorities under all circumstances to receive trade effluent?—I think so.

11940. You think notwithstanding such difficulties?—I think if the Corporation clauses put in our Act of 1898 could become general, I do not think any manufacturer would object to it; I do not know whether or not you have a copy of the clause.

11941. But do you think it practicable to lay down legislative enactments which would fit all cases?—I do not know of any special case which it would not fit.

11942. (*Professor Ramsay.*) Suppose a manufacturer has been in the habit of being connected with the sewers for a long time, and turns out an effluent which is difficult to treat, is it not that which causes the difficulty when the Corporation objects to his turning out a bad effluent into the sewers?—Well, I suppose if there is any chemical in connection with his effluent—if there are certain chemicals—it may be detrimental to the land, to the crop that may be on the land; but so far we have had no experience of that, sir.

11943. (*Sir Michael Foster.*) You are only regarding it from the view of land treatment?—Of land treatment.

11944. Because you have no experience of other treatment?—No.

11945. (*Chairman.*) Do you think that the powers of local authorities to compel manufacturers to carry out certain conditions antecedent to receiving their effluent are sufficient?—I think so.

11946. Generally you are quite satisfied with the law on all these matters?—Yes; I particularly refer to our own law.

11947. That is your local experience?—Yes. We got very exceptional powers in 1898 under our Act.

11948. (*Sir Michael Foster.*) Exceptional powers?—Exceptional powers, yes.

11949. Was it a special Act?—Yes.

11950. For yourselves?—Yes.

11951. (*Chairman.*) To call upon the manufacturers to treat their effluent before it entered into the sewers, so that it should not be detrimental to the sewers or the land treatment. That has facilitated your work of late?—It has, certainly.

11952. But you had not any manufacturer who had acquired any rights by long usage, had you?—Well, there has been one case where he claimed rights by long usage, and he has had to give way. He thought he had a prescriptive right, but he has come to the conclusion that he has not.

11953. (*Sir Michael Foster.*) You found it desirable or necessary to have a special Act of Parliament for your borough?—Yes, we did. I shall be very pleased to give you a copy of the clause. That is a copy of the conditions that we ask the manufacturers to enforce.

BOROUGH OF KEIGHLEY.

January 18th, 1898.

Conditions under which the Corporation are prepared to admit Trade Effluents into the Public Sewers.

The volume of waste water shall be reduced as far as practicable; as, for example, by keeping condensing water and surface water out of drains.

All trade waste waters except suds shall first be passed through coke filters, on the downward and upward principle, before the Corporation can receive the effluent into their sewers.

Suds in all cases shall be treated for the removal of grease, and after sufficient time has been allowed for precipitation of the grease, the liquid shall then be drawn off by means of a floating arm, and, after passing through a coke filter on the downward and upward principle, may be discharged into the sewer.

The time of discharge shall be so regulated by the Corporation that all the trade waste waters shall not discharge into the sewers at the same time.

A manhole or other opening shall be provided to the satisfaction of the Corporation, on the line of drain between the mill and the Corporation sewer, and the officers of the Corporation shall have the right to take samples at this point, and to inspect the tanks, at any reasonable time.

Before commencing any works for the treatment of trade waste waters, plans shall be submitted to the Corporation for their approval.

In the event of any of the foregoing conditions and regulations not being complied with, the liberty to discharge trade effluents into the Corporation sewers shall be *ipso facto* suspended so long as such non-compliance continues.

11954. (*Chairman.*) But you are quite conscious that there are cases where manufacturers draw from a stream, and are bound to return to the stream the same volume that they withdraw?—Oh, yes; in our case, where the manufacturer takes from the stream, it would not make the slightest difference, because the stream is so large, taking the amount which he abstracts would not make any difference whatever. These are copies of our special clause, which I think, if they were adopted, would answer nearly every town.

Section 59, Keighley Corporation Act, 1898.

It shall not be lawful for any person to cause or suffer any refuse from any manufactory or work that would be destructive or injurious to any sewer, or that would interfere with the treatment or utilisation of the sewage of the district to flow or pass into any sewer of the Corporation, or to flow or pass into any drain, channel, or watercourse communicating with any sewer in such manner that the same will be carried by, through, or out of such drain, channel, or watercourse into any such sewer; and if any person is guilty of any act or omission in contravention of this section he shall be liable to a penalty not exceeding twenty pounds, and in case of a continuing offence to a further penalty not exceeding forty shillings for every day during which such offence continues, after the expiration of a time to be determined in that behalf by the court of summary jurisdiction before whom he is convicted. Provided that any person charged with an offence against this section shall not be convicted thereof, if he shows to the satisfaction of the court of summary jurisdiction before whom he is charged that he has duly used the best practicable and reasonably available means of depriving the refuse from his manufactory or work of qualities that would make it injurious to the sewer, or likely to interfere with the treatment or utilisation of the sewage of the district. A person shall not be liable to a penalty for an offence

against this section until the Corporation shall have given him notice of the provisions of this section, nor for an offence committed before the expiration of one month from the service of such notice, provided that the Corporation shall not be required to give the same person notice more than once.

11955. Then, situated as you are at Keighley, you have met with no difficulty, partly because of your having this and partly because of the readiness of the manufacturers to fall in with the conditions that you have laid down?—That is so.

11956. And you have found in practice that the reception of trade effluent has not prejudiced your treatment of the sewage, nor have the works which the manufacturers have carried out been carried out at ruinous cost to them?—That is so. We ask them to do the least possible work; just to intercept the solids, and we are not particular about the colouring matter in connection with the suds.

11957. (*Dr. Burn Russell.*) With reference to these clauses in your local Act, had you any precedent for them when you were before the Committee?—Well, we thought we had better have special powers on account of the wool combers' suds; that was the great trouble with us—I think that Act covers it which says that they shall reasonably treat before it passes into the Corporation sewers.

11958. So that you established a precedent by this local Act?—Yes.

11959. Do you know if any other localities have adopted your clauses or anything like them?—I do not know of any town, unless it is the city of Bradford, that has tried to get powers; whether they succeeded or not I cannot say.

11960. You do not know whether they got them or not?—I know that they got certain powers in Bradford that they should compensate the manufacturer if the manufacturer had to put down works.

11961. (*Chairman.*) I think they have not carried out these powers?—I do not think they have. And they also got special powers to put down special sewers for trade refuse. You will notice in the conditions there that they have to crack their suds; preliminary treatment.

11962. These conditions seem extremely simple; they simply refer to the removal of solids and the removal of grease?—Yes, that is so.

11963. And happily, in the removal of grease the cost of such removal is largely borne by the grease which is obtained by the manufacturer from the suds?—I was speaking to a manufacturer the other day, who says it pays him to crack his suds; to remove his grease.

11964. By cracking, do you mean treatment by sulphuric acid?—Yes.

11965. Then, does that treatment by sulphuric acid remove all the grease?—Yes, practically it does.

11966. At any rate, it does not prejudice your treatment; there is so little grease left?—It is so little it does not affect the land.

11967. (*Dr. Burn Russell.*) Have you any trouble with the Rivers Board in your district?—No, we are on very good terms with them, and it is very seldom that they have to complain about our effluent.

11968. (*Chairman.*) In the event of any difficulty arising between the local authority and the manufacturers, it is evident that it would be necessary to refer that difficulty to somebody outside themselves. Would you prefer to do so to a court of law, or, for instance, to the Rivers Board or to some central authority in London?—I should prefer to refer it to a central authority, because, in the first instance, law is very expensive, and I think if the central authority were composed of experts it would be to the advantage of all.

11969. You think a central authority in London would be useful?—Yes.

11970. As an ultimate court of appeal?—It is better to appeal to them than to the local authorities. *Mr. W. Hopkinson.*

11971. Unless you wish to bring any matter before the Commission upon which you have not been asked questions, we need not detain you?—I have put down some small bacteria beds; I do not know whether you would care to know about those; they have answered very well up to now. 3 June 1902

11972. If you have anything to say to us about the bacteria beds and the influence upon them of trade refuse that might be useful?—Well, up to now the trade refuse has not affected that in any way.

11973. You have found you can carry out your bacteria treatment without injury arising from the trade effluents?—Yes, and we get very good effluents from them; very clear.

11974. What is the nature of the wool washers' effluent; after the grease has been withdrawn, it is not difficult to treat, is it?—Oh, no; I do not think it is much different from ordinary sewage, from domestic sewage; I could show you a sample if you would like to see a sample of it.

11975. Well, if you have one?—I have brought a few samples, not knowing whether you might not want to see some of them.

11976. Are you experimenting with bacteria beds as an alternative to the extension of your land process?—Yes, probably the Committee may think it sometimes advantageous to use bacteria beds instead of land.

11977. And, so far, you seem favourably impressed with the bacteria bed for this mixed sewage?—Yes, that is wool combers' suds.—(*Exhibiting sample.*)

11978. This is the effluent before it is treated at all?—That is before it is treated.—(*Producing sample.*)

11979. And what is this? But you have not been passing the wool combers' suds without preliminary treatment on to bacteria beds, have you?—No, not direct, only mixed with sewage. A short time ago some wool combers' suds did come down untreated, but it did not make any difference to the bacteria bed.

11980. Probably because the volume was small?—That is so; they will be sending perhaps 5,000 or 10,000 gallons a day. That is how we admit it into our sewers.—(*Producing sample.*)

11981. The processes do not seem to me to be very effective as measured by the figures of the analyses?—In previous ones it has been much better than that, and I cannot account for this second one.

11982. (*Professor Ramsay.*) Have they been going long?—They have been going since August of 1900.

11983. (*Chairman.*) May we take it that the final result you obtain is approved by the Rivers Board?—Well, they do not see the result, the Rivers Board, because it goes into the general effluent from the farm. They are only very small tanks 10 feet square, they go into the general farm effluent.

11984. So far as you know the Rivers' Board have not made any analyses of the effluents from those two tanks?—No, they have not that I am aware of.. That is a sample of the farm effluent.—(*Sample produced.*)

11985. From what process?—By treatment intermittent downward filtration.

11986. Through land?—Yes, through land. It has not been uncorked since it was put in. I do not know whether there is any smell from it. That is Keighley sewage—it is only weak. I am afraid that is tanners' effluent. That is the tanners' before treatment, and that is after.—(*Samples produced.*)—I am not at all satisfied with them.

11987. There are solids in them?—There are, too much solids; I must ask them to go through some further treatment.

11988. We are obliged to you for coming before the Commission and giving the evidence that you have given?—I could leave you a copy or two of these conditions if they would be of any service to you.

FORTIETH DAY.

Wednesday, 4th June, 1902.

PRESENT:

The Right Hon. The EARL of IDDESLEIGH (*Chairman*).

Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Mr. W. H. POWER, F.R.S.
Professor RAMSAY, F.R.S.
Colonel HARDING.
Dr. BURN RUSSELL.

Mr. F. J. WILLIS, *Secretary*

Mr. J. E. Sharpe.

4 June 1902.

Mr. J. E. SHARPE, called; and Examined.

11989. (*Chairman.*) You are Mr. Sharpe the Engineer and surveyor of Otley?—Yes.

11990. Do you admit manufacturers' refuse into your sewers?—Several firms have discharged manufacturers' effluent into the sewers for many years, but refuse from no additional works has been admitted since 1895.

11991. Does that mean that you have had no applications to admit additional works, or that you have refused?—We have had no applications.

11992. What is the kind of refuse, and what is the volume as compared with the volume of ordinary sewage?—The refuse is from paper works, tanneries, fellmongers, woolwashing, and dye water, amounting altogether to 36 per cent. of the total flow.

11993. Do you find that the mixture of trade refuse materially increases the difficulty of treating sewage?—I do.

11994. Apart from necessitating an increase in the size of the works?—Yes, I do.

11995. And from what does that difficulty arise?—From the nature of some of the refuse, which, in one case, is grease, and in another the volume which amounts to 33 per cent. of the total volume of sewage.

11996. Has anything been done to remove the grease?—Yes, there is a little preliminary treatment, but it is not all treated.

11997. Is that preliminary treatment carried out by the local authority, or by the manufacturers themselves?—It is carried out by the manufacturer who cracks the suds by putting sulphuric acid into them. I have the particulars of the treatment here. The volume of refuse from the woolwashing is not a very great quantity—400 gallons per day. The water from the washing bowls, except the bowl bottoms, runs to the sud settling tanks, and is pumped to the grease works and treat. The bowl bottoms left are run separately into sud settling tanks and turned almost immediately into the sewers. The treatment at the grease works, I do not know whether you care to go into that or not; the treatment at the grease works is as follows:—The refuse water from the sud settling tanks is conducted by pumping into wooden tanks elevated above the ground. Sulphuric acid is added to "crack" the suds, and is then allowed to remain in the tanks two or three days, when the top liquid is pumped into the sewers. The remaining matter left in the wooden tanks is then run into filter cloths, remains there three to four days, after drying it is then put into cloths and taken to the presses where the brown grease is extracted, and then sold, the present price being £12 10s. per ton. The solid matter remaining after pressing, and called the sud cake, is also sold, probably for agricultural purposes. That is the treatment for woolwashing by the manufacturer.

11998. Do you find that the manufacturers are willing to do what they can to get their refuse into such a state as to be capable of going into the sewers without increasing the difficulties of treatment?—The only reason why the bowl bottoms are run into the sewer is because they cannot get any grease from it, so they do not treat it. I might say that in several cases we could have taken steps to call upon these people to take the objectionable matter from the sewers, but the difficulty arises, they claim a prescriptive right. That is a sample of the woolwashing refuse after being "cracked." (*Showing sample.*)

11999. (*Colonel Harding.*) Then, what they do is done, not for the purposes of purifying the effluent, but of extracting grease at a profit?—That is so.

12000. (*Chairman.*) Have you ever asked them to take steps towards purification?—The only thing I have asked them about is, the bowl bottoms. They always used to turn the bowl bottoms down the sewer at one time, and I asked them to turn it down intermittently, and they fell in with the suggestion.

12001. And that they have done?—That they have done. Yes, it improves matters very much.

12002. Do you think that a local authority ought to have power to construct sewers for trade refuse alone?—Broadly speaking, yes. In my opinion authorities should be given the option of constructing a separate system for such portions of the trade refuse as they may think desirable, on account of the difficulty of treating the sewage when combined with such trade refuse, and where the difficulty is increased by the varying nature of the sewage solely owing to the trade refuse, and necessitating at different times of the day the use of not only a large amount of precipitant, but perhaps the use of two kinds, depending upon the volume of trade refuse present in the sewage. I might say that this would not apply to Otley; I do not think it would pay Otley to do that.

12003. Are the positions and rights of the manufacturers and the local authorities under the existing law clearly defined?—My council have had difficulty with most of the firms in Otley, who claim a prescriptive right to discharge their trade refuse direct into the sewers, without any or very little treatment, and as the council are in doubts as to their position these manufacturers have been allowed to discharge into the sewers up to the present. I think it very desirable that the law should clearly define the position of manufacturers and local authorities in such cases. Authorities should also be given power to make bye-laws—subject to confirmation by the Local Government Board, regarding the admittance of trade refuse into the public sewers.

12004. Do you think the law ought to be altered so as to give manufacturers greater rights than at present to connect with sewers?—I think these rights are sufficient at present.

12005. Do you find manufacturers willing to adopt means for the removal of suspended solids from their trade refuse before discharging into the sewers?—No, not if the means suggested would incur any moderate expense.

12006. You have found them willing, in fact, to meet you if it does not entail any expense?—That is so; yes, that is so.

12007. But they object to incurring any further expense?—That is so.

12008. And their argument, broadly speaking, is that they have already got their rights, and there is no reason why they should not exercise them?—That is the position which they take up.

12009. Do you consider that any further safeguards should be required in order to secure the trade refuse doing no harm to the sewer, and, if so, what should they be, and how should they best be enforced?—As stated in my reply to No. 6, most of the firms in Otley claim a prescriptive right to turn their trade refuse directly into the sewers without any, or very little,

treatment. This refuse contains much that is injurious to the sewers. In one instance a firm of fellmongers discharge a quantity of trade refuse containing lime and hair, the lime acts in some degree as a precipitant, and causes the suspended matter in the sewage to settle and become matted with the hair and other fibrous matters, causing the sewer to become almost choked with a substance not easily removed, and with a result that a serious expense is incurred in keeping the sewers clean. That is a sample, you see the solids accumulation in the bottle, that is lime.—(*Showing samples.*) In another case a firm discharge refuse from woolwashing into the sewers, the bulk of this is partially treated, but periodically what are known as "bowl bottoms" (consisting of the settlings in the receptacle used for washing the wool) are discharged into the sewers. These bowl bottoms are the cream of the refuse, and the discharge of it into the sewers along with others has resulted in a great measure in the failure of our disposal works, the land having become coated over with a greasy film, preventing the percolation of the sewage, with the result that the land has been waterlogged for many weeks together. Owing to the failure of our existing disposal works, caused by grease and the largely increased volume of trade refuse, the council are now incurring a considerable expense in extending their disposal works, by more than doubling the area of land, and increasing the tank capacity by 60 per cent. This expense may remedy matters for a time, but unless manufacturers who claim a prescriptive right can be dealt with a similar state of things may possibly arise in the future.

12010. Do you think that there should be some tribunal other than the ordinary courts of law, for example, such as a central government authority, to whom an appeal could be made when a local authority refused to allow trade refuse to go into the sewers?—If matters in dispute could be referred to either the Local Government Board or some such authority as suggested in the query, a great deal of expense might be saved.

12011. Should manufacturers be required to pay a special rate or charge in those cases where they are allowed to connect with the sewers, and, if so, how would you suggest that the amount should be determined?—As a rule, where the volume of trade refuse from any one firm is very large, the water is first drawn from a river or stream; in such cases I suggest that the authority should have power if they think desirable to call upon the manufacturers to provide a site, construct works, and deal with their own trade refuse to the satisfaction of the Rivers Board. In such cases the manufacturer should be exempt from paying rates for capital expenditure and maintenance of the local authorities' sewage disposal works. I here refer to those cases where the trade waters are not of a very bad character, and such as can be dealt with in a comparatively small space, such as by continuous flow filters. In the cases of existing manufacturers, the filtration works to be constructed by the authority on a suitable site provided by the manufacturer, any steam or other power required for pumping being also provided by him, and the treatment when the works are completed to be carried on by the manufacturer, he still paying his proportion of any capital debt on the sewage disposal works until the same is extinguished, but to be exempt from paying any rates as regards maintenance. If the means suggested were adopted, they would have a beneficial effect on the stream, as the purified effluent could be turned back into the stream at a very little lower down than the point of intake. It would also cause the manufacturer not to take more water from the river than is absolutely necessary for his purpose. If the manufacturer cannot provide a site for purification works, then the authority may allow the same to be connected to the sewer, if of sufficient capacity, but the manufacturer should pay a special rate or charge, based on the quantity as compared with the total dry weather flow at the sewage disposal works. I should like to give one instance showing how serious the cost is to my council owing to the discharge of a large volume of trade refuse from one works. The firm I have in mind, with a rateable value of £400, discharge into the sewers about 33 per cent. of the total flow. The cost of maintaining our disposal works without any capital charge comes to £225, or about 2d. in the £ per annum; on this basis the firm mentioned contribute only £3 6s. 8d. as their share of the cost, which, if worked out in the proportion of the volume discharged into the sewers, would amount to over £72. This is a sample of what this firm turn in. It looks rather bad now. This is what it is as a rule (*showing samples*). I think this water comes from the rag-boiling machine, and they have had some dark coloured rags in.

12012. (*Dr. Burn Russell.*) What is the nature of the work?—Paper works. As a rule it is more of a brown colour.

12013. (*Chairman.*) What are the reasons generally advanced by local authorities for refusing to allow trade refuse to go into the sewers?—Volume, and risk of injurious matters being turned into the sewers through neglect or carelessness of workmen, the prevention of which would in many cases mean a systematic inspection at frequent intervals.

12014. What would be the effect upon the flow of the water in the stream in a case, in which the manufacturer uses the water from the stream in his manufacture, if the trade refuse were delivered into the public sewers?—Well, I do not think that question affects Otley at the present time. The river is of large volume, and what is taken out is not noticed.

12015. In such cases is any alteration of the law desirable so as to get over the difficulty of riparian rights?—I should say yes in cases where the volume of water taken is a very large proportion of the total flow of the stream. My reply to No. 12,011 may suggest a possible way out of the difficulty.

12016. (*Colonel Harding.*) You told us that no new applications had been made to you for connection with the sewer by manufacturers?—That is so.

12017. Are we to take it, then, that all the manufacturers already are so connected?—Yes, they are.

12018. We may gather that Otley is, in regard to manufacturers turning out effluents, not a progressive place?—Well, not in that respect, no; but most of the works are engaged in the making of printing and other machines.

12019. You have had no new works established for some years?—Not of that character, no.

12020. Then the law is quite sufficient, is it not, to enable local authorities to make conditions with manufacturers before receiving their effluents, where they have to make application to the local authority?—Yes, I take it that is so; but I think the authority should make some regulations, something that they can work on, and something that they can compel.

12021. You think the authority should make byelaws—lay down definite conditions?—I do, subject to the confirmation, say, of the Local Government Board or some other Board.

12021.* So far as you know their powers are sufficient to do that?—Well, I would not say.

12022. Suppose in your district there was a new manufactory established, and they applied to you to receive their effluent, would you, under the existing powers of the law, be able to make arrangements with them to take it under certain conditions?—I take it we should.

12023. Then your difficulty arises with those manufacturers who have been connected with your sewers for many years?—That is so; we have had a very great difficulty indeed.

12024. But in times past you were not called upon to treat the flow from your sewers in any way?—Everything went into the river.

12025. And new conditions have come about quite recently?—That is so.

12026. It is a legal question which is not for either you or me whether these new conditions affect the question of the prescription?—The case of the Honley Urban District Council *v.* Eastwood is the case which rules on the point, and that is all against the local authority.

12027. But you are quite clear that local authorities situated as you are ought to be given powers to regulate the conditions?—I am, certainly.

12028. Under which they would receive or continue to receive effluents?—Yes, I think it is very desirable indeed; it puts us in a very great difficulty.

12029. Do you think that the Watershed Rivers Board would be a good authority to appeal to in the first instance in case of difficulties arising between local authorities and manufacturers. For instance, in your case it would be the West Riding Rivers Board?—I should think they are more capable of judging than anyone else—the Rivers Board.

12030. Your authority would, so far as you know, have confidence in appealing to them?—I think so.

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12031. In the first instance with power of appeal to a central rivers authority?—I think so; there is only this about it, the Rivers Board in their district may have some firms turning refuse into the streams, which, perhaps, is not of a very polluting character, but still at the same time they would like it out of the river. The result is they try to persuade the manufacturer to take it out of the river and put it into our sewers, so naturally I take it they would look out for their own interest—the Rivers Board.

12032. You think the Rivers Board's policy would be generally to facilitate the turning of effluents into the sewers?—I think so.

12033. And that you do not like?—That is my opinion. Now, in the case of this firm who make paper, they have at the present time a part of their trade water, which is not very bad, going into the river. The Rivers Board have called his attention to it; they have not taken any strong measures; they suggested to him that he should turn it into the sewer. That is an instance.

12034. Yes; but do you not think that, speaking generally, it is good policy for the authority to put no difficulties in the way of the development of trade in its district, and to receive effluents, provided certain conditions are fulfilled by the manufacturer?—Yes, I agree with that, provided the conditions are stringent enough.

12035. Well, it would be for the local authority to agree with the manufacturer upon those conditions?—Yes.

12036. And if the manufacturer turned out an effluent which was not of excessive volume?—Yes.

12037. And if he would agree to settle the solids?—Yes, that is so.

12038. To withdraw the grease?—That is so.

12039. To turn it out in a regular flow instead of rushes?—Yes.

12040. You could probably then deal with it?—Yes, we could.

12041. If you did not so deal with it, and you put conditions in the way of the manufacturer, and he is compelled by the Rivers Board to do the work himself, it is probable, is it not, with the multitude of small works of this kind in the district, that the work will not be so well done as if it were done by the local authority?—Well, my opinion, as I have stated already with regard to those firms who have a very large volume, is that they should treat their own, because I do not think it is fair that the public should have to pay the greater part of the cost of treating his trade water. As I have stated in this instance the man who turns his sewage in pays £3 6s. 8d., his proportion of treating one-third of the sewage flow, whereas if he were charged on the basis of his flow he would have over £70 to pay.

12042. I gather from your answer that you think it is not possible for the law to lay down conditions which shall be universally applicable?—No, I do not think so.

12043. That cases must necessarily be considered on their merits?—That is so.

12044. And that, therefore, some power of appeal to some body, judicial or other, must be allowed when difficulties arise?—Yes, such as you suggest in your queries here, or the Local Government Board.

12045. (*Dr. Burn Russell.*) What is the population of your district?—9,230.

12046. This paper work seems to supply all but 3 per cent. of the total?—33 per cent., yes, over.

12047. Yes, but you told us that the total amount of trade refuse that you had to deal with was 36 per cent. of the sewage?—Yes, that is so.

12048. So that leaves only 3 per cent. for the remainder?—For the remainder—I can give you the quantities—the approximate quantities—those are approximate.

12049. I do not think it is of any great importance. Have you had any experience of works that are supplied with water by meter?—We have several firms in Otley who have water supplied by meter.

12050. I think you said in your evidence that when they supplied themselves without stint from the river the discharge was always very copious?—Yes, especially in the case of the paper works.

12051. Do you not think that that indicates that as long as they get rid of any quantity of refuse water without any extra cost, they will not trouble themselves at all to reduce the quantity of it by care in the use of water in their processes?—I do not suppose they will do that. I take it the more water they use in the paper works the better it is for them; they can carry on their work better. If they had all their trade refuse to treat I do not think they would use so much.

12052. That is exactly what I wanted to bring out. It seems to be consistent with what we know of human nature, and if they had to pay for the treatment of their refuse water they would be very careful to minimise the amount of it?—Yes, that is what I say; I say that in my evidence, I think.

12053. I do not think you stated it exactly, but I drew the inference from what you said about the experience of firms who derived their trade water from streams without any stint?—Yes.

12054. (*Major-General Carey.*) The flow from the Otley Sewage Works is unsatisfactory at present, I understand, owing to the combination of untreated trade water with your sewage?—Well, at the present time we have laid out eight acres of new land; we are putting down new tanks, and the sewage from the new land at the present time is as clear as spring water.

12055. That is sewage combined with trade water?—Yes.

12056. And that is untreated trade refuse?—Yes, trade refuse similar to this, because that is new land, therefore mind, I do not say what it will be in a year or two's time, but we cannot get the good effluent from our old land; it is impossible for us to do it.

12057. (*Colonel Harding.*) Is that because it is choked?—It is choked. Another thing, I rather think there are too many drains in; that is another reason.

12058. Then you do not in the least despair of dealing with this mixture of sewage and trade effluents if you had sufficient land?—No, we do not despair of it, only my great argument is that this firm of paper works should not turn all this water in; I do not think it is right they should do it, because they do not pay in proportion to what they turn in. I might say we are also putting down three new open septic tanks, making a total of five, bringing the capacity up to about 420,000 gallons.

12059. (*Major-General Carey.*) In your answer to a previous question you say that the reason generally why trade effluent is not satisfactorily dealt with is owing to the carelessness of the workmen?—Yes.

12060. Therefore you do not anticipate that if the works were carefully carried out, and without any neglect, there would be any difficulty in dealing with this trade effluent?—As a rule I do not think there would, but of course the difficulty would be always there that people are liable to neglect the work of treatment if it is getting on towards closing time, and there is something else to do. Take the case of this wool washing, they can get rid of their refuse quicker by turning it into sewers rather than by pumping it into the suds settling tanks, if it is getting on towards closing time close upon half-past five, they may turn it directly into the sewers. It is all carelessness. I do not say the principals of the firm would permit it if they knew.

12061. But the quality of the trade water does not enter into the reasons of the local authority for refusing to allow it to enter into the sewers?—No, if the solids were taken out; I do not think it would if the solids were taken out as much as possible, if all the solids were taken out I do not think it would matter much.

12061*. Is your effluent at present passed by the Rivers Board as satisfactory?—Yes.

12062. (*Chairman.*) I did not quite catch what you said to Colonel Harding about the Rivers Boards. Colonel Harding asked you whether you thought that the Rivers Board would be a good tribunal to decide between traders and local authorities if there were any question between them?—Well, in the first place I said I thought they would, and then afterwards I qualified it by saying that it is to the interests of the Rivers Board to get water which is not of a very polluting character out of the rivers into the sewers, and I gave one firm as an instance. The Rivers Board have drawn the attention of this firm to some slightly polluting

liquid being turned into the Wharfe, into the river now, and I understand that the owner is going to turn it into the sewer. That just gives an instance.

12063. Then do you mean that in your opinion the Rivers Board would be likely to say in a case, "Oh, turn it into the sewers"?—Yes, that is my opinion.

12064. And therefore, if the local authority did not want to have it in the sewers, they would have a sort of an idea that the Rivers Board policy was a policy of turning it into the sewers?—I think so; it seems to be that at the present time.

12065. (*Colonel Harding.*) But do you think that the Rivers Board would, if it had the power, decide in such a case without considering the reasonable conditions which the local authority might require to be first carried out before an effluent was turned into the sewers?—Well, I can only give this one case as an instance; I cannot say anything more about it. Of course, if they treat the matter as they should do, and looked at it in the proper light, I daresay the Rivers Board would be all right. The question is, will they do so.

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Mr. BERNARD POWELL, called; and Examined.

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12066. (*Chairman.*) You are, Mr. Powell, engineer and surveyor of Handsworth?—I am.

12067. Do you admit manufacturers' refuse into your sewers?—We do, in the shape of tannery refuse.

12068. What kind of refuse do you admit; and what is the volume as compared with the volume of ordinary sewage?—With regard to the tannery, which is the only trade refuse we get, we receive about 1,000 gallons a day, and the outfall which that goes into is about 32,000 gallons a day. You see the district which I represent is a very difficult one to deal with, and we have no less than eight sewage farms in the district, which is only about 4,000 acres, and most of them receive domestic sewage only, and are but small farms, of course, that accounts for the very small volume going to this one outfall.

12069. Do you find that the admixture of trade refuse materially increases the difficulty of treating the sewage apart, that is, from necessitating the increase in the size of the works?—Yes, without doubt, we have had very great difficulty with the refuse referred to, the tannery refuse, and, in fact, on several occasions I think previous to my going there, not since I have been there, there were several law suits on in regard to it, their having sent the sewage down and choked our bacteria beds which we had formed at the Outfall Works.

12070. If so, from what does this difficulty arise, from the condition or the kind of the refuse, or from its volume?—It arises from both, both the condition and kind, and also from the volume. It causes us to treat it separately. We have tanks set apart on purpose for receiving that refuse alone, and we have come to an arrangement with the tannery to let us know when they are about to let off their tanks, and the tanks are let off at certain times arranged with them, of course, we just turn all the sewage during the time that it (the trade refuse) is running, into special tanks set apart for that alone. And as stated above, this refuse has to be specially treated, and particularly from the fact that it is sent down intermittently, thereby abnormally increasing the flow at intervals, and to the limes which come down from the tannery, which, in my opinion, very materially increase the quantity of sludge formed. Great difficulty also arises from the chemical change in the sewage produced by the admixture of the trade refuse, in addition to the large increase in the amount of sludge before referred to, the tannic acid in the trade refuse causing the domestic sewage to change colour, and the effluent after passing through efficient bacteria beds, double-contact, is both dark coloured and unsatisfactory, and even after passing through our land we occasionally find that it is very discoloured, and the effluent from the broad irrigation is often of an unsatisfactory character.

12071. Do you think a local authority should be empowered to construct sewers for trade refuse alone?—Under certain conditions I think possibly it might be an advantage—for instance, when a very large proportion of the trade waste is liquid and innocuous, or inoffensive, so that its treatment would be more easily and economically performed than in the case of ordinary sewage. I also think local authorities should have power, subject to inquiry and consent being given, as to the special facts in any case where such powers are applied for—viz., where there is a particularly difficult and obstinate trade refuse to deal with, and when the admixture of this with the domestic sewage would increase the difficulty to the extent of the added quantity.

12072. Are the position and rights of the manufacturers and local authorities under the existing law clearly defined?—I do not consider that they are. They are very inadequately and unsatisfactorily defined.

12073. Should the law be altered so as to give manufacturers greater rights than they at present possess to connect up with the sewers?—I should most certainly say no, except under very stringent safeguards.

12074. Could you specify any such cases?—The manufacturers should be obliged to regulate their discharge, and make it as uniform as possible, and this has been done by arrangement in the Birmingham district in the case of manufacturers discharging acid waste. Where large quantities of sediment are present in the waste this might be regulated by a standard, and in every case the local authority should have the power to determine the method of the discharge. I might state that I held an appointment under the Birmingham Drainage Board, and was connected with the sewage works and farm just at the time that they were putting down experimental bacterial beds for treating the sewage, and that is why I have referred to the Birmingham district here.

12075. Could you give us any particular safeguard that you would recommend or say anything about—how the supplying of such safeguards should be enforced?—I am not prepared to generalise. In the case of pickling and other wastes, enormous quantities of inoffensive suspended solids go into the sewers, and are deposited along with other matters at the sewage works as offensive sludge. This suspended matter might be kept back by means of screens and settling tanks at the works where produced, to the very considerable advantage of the sewage authorities. In fact, this is now being done in my own district in the case of the tannery before mentioned, and in my judgment should be done in all cases. We have caused them to put down three settling tanks at the tannery, in which they have had to pump all their tannic acid and also the limes and any other refuse that they make, and it passes first into one tank and from that into the next by means of falling over a weir, which also has a floating scum-board in front of it, and from that again into the third tank, which has a floating arm, and that is where we regulate it, letting it off at certain times. I am also thinking, and I am trying to make arrangements now, to rearrange that, so as to allow the effluent from the third tank to be extended over the whole period of the 24 hours by having a small pipe connected with our sewer, so that it might continually run away, and by that means intermix with our sewage more fully, diluting it to such an extent that it would have no effect at the outfall works, and treat it with the ordinary domestic sewage. That is what I am wanting to do now; and has been done in Birmingham in many cases.

12076. Do you find that manufacturers are willing to adopt means for the removal of suspended solids and grease, etc., from their trade refuse before discharging it into the sewers?—No, not generally; as a matter of fact, in some cases it is very difficult to get them to do anything without severe measures are taken. For instance, in our own case, as I have said previously, we have had on several occasions to threaten them, and also take action against them, before we could get them to do anything, and I think this arises from the lack of the powers of the local authorities as understood by the makers of trade refuse, and their rights as to the admission into the sewer.

12077. Should there be some tribunal other than the ordinary courts of law, such, for instance, as a Central Government Board, to whom an appeal could be made when a local authority refused to allow trade refuse to go into the sewers?—I have said here no, but since then I have rather altered my opinion; and I say also, that local authorities do not object to take trade refuse, providing suitable measures are taken by the manufacturers to prevent increased difficulty in the treatment of the sewage at the outfall works, and in the case of the constitution of such authority, I have suggested here that the Rivers Board for the district should be the court of appeal; but since then I have found out that the Rivers Boards are partly formed by manufacturers,

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and therefore I hardly think that the Rivers Board should be, as they might lean rather towards other manufacturers; so I should rather suggest such an authority be formed in the same manner as the Local Government Board, so that a special Board be formed from that body, being quite independent.

12078. Then, in fact, you would be in favour of some Central Government authority?—I think it would be an advantage, so long as that authority was quite isolated and had no feeling in the matter.

12079. Should manufacturers be required to pay a separate rate or charge in those cases where they are allowed to connect with the sewers?—I think most certainly they should. The charge might be determined by computing the average cost of disposing of liquid sewage and of sludge respectively, and calculating the manufacturers' refuse from the average volume of discharged liquid sewage and from the total average of suspended matter discharged as sludge; and I think that there is no doubt that this should be paid for by the manufacturer, as the sewers are not put down to deal with manufacturers' refuse; they are put down to deal with domestic sewage, and the manufacturer makes the trade refuse for his own gains, and I do not see why the inhabitants of the place should have to pay as much in proportion for the sewers as the man who gets an advantage out of using them.

12080. What are the reasons generally advanced by the local authorities for refusing to allow trade refuse to go into the sewers?—Naturally, the greater difficulty in dealing with the sewage and purifying same at the outfall works in order to maintain the standard of purification required by the Rivers Board; increased capacity of sewers required to accommodate the trade refuse and the ordinary flow of sewage; increased tank capacity at outfall works and land for purification.

12081. What would be the effect upon the flow of the water in the streams in those cases in which the manufacturer uses the water from the stream in his manufactory, if the trade refuse were delivered into the public sewers?—I should say that this would entirely depend: first, upon the volume of water usually passing along the stream; and, secondly, upon the amount taken by the manufacturer from the stream in proportion to the flow of such stream.

12082. In such cases is any alteration in the law desirable so as to get over the difficulty of riparian rights?—I am not sufficiently conversant with the law to say; but there are two cases in my district where the water is taken from the River Rother and returned again to it after passing through the works. One is a large iron works and the other a spade and shovel works. My suggestion to get over the difficulty mentioned would be to enforce the manufacturers to treat their trade refuse, and afterwards deliver back into the stream, instead of into the public sewer. I might say that the two works that I have mentioned, one works which is above the other recently had a law suit with the lower works on this subject. The owner of the lower works said that those above were taking the water away from him; but I believe in the settling of the case it was given in favour of the upper works. There is no doubt if the water were taken out of the stream and taken into the public sewer it would lessen the amount of water lower down, and would injure riparian rights in that way.

12083. (*Colonel Harding.*) You think that the local authority, as representing the whole of the people in a district, is clearly interested in the improvement of the condition of the rivers and streams passing through its district?—I think there is no doubt about that, sir.

12084. And that, therefore, the local authority would naturally support the methods which it considered to be the most effective for the purpose?—I think so, yes.

12085. Now, where there is a number of manufacturers turning out a relatively small volume of effluent, do you think the work would be better done if each small works were called upon to put down purification works of his own, of if the effluent, subject to certain conditions, were turned into the sewer and dealt with elsewhere by the local authority?—I think, if they were merely small manufactories, possibly it might be best for them to pay an extra charge, and for the local authority to deal with it at one works.

12086. I am not touching the question of payment at present; but as regards the effectiveness of the work to be carried out, do you not think it would be better done if done wholesale by the local authority?—By the local authority, I should say so. Of course, it depends in a great measure on the kind of refuse they were delivering into the sewers.

12087. But subject to proper conditions for treating that you think effluents received into the sewers would be more effectively dealt with wholesale than separately by the manufacturers?—I think it is most likely that it would be more effectually dealt with, because the local authority would be obliged or would have to do their best to get their effluent suitable to pass the Rivers Board, and the manufacturer might possibly just treat it in the manner that was arranged originally, and later he might get careless and send unsatisfactory refuse into the sewers.

12088. It is exceedingly likely that where a great many small works are carried on in that way that there would not be adequate supervision?—Yes, quite so.

12089. You say that the position of local authorities in these matters is not cearly defined in regard to the law. Now you gave us an instance nevertheless where your authority had successfully arranged with a manufacturer to put down settling tanks?—Yes.

12090. And to let off the effluents from those tanks at stated times?—Yes.

12091. And you told us further that you were beginning to induce him to let it off in a regular flow, spread over the 24 hours?—That is so, yes.

12092. Well, as the law permits you to make arrangements of that very kind with the manufacturer, where is the difficulty?—Well, we had to go to a great deal of expense to get them to do that, whereas if the law were clearly defined, and they had this put before them by the clerk of the authority, I take it they would at once agree to do what was required.

12093. But what expense had you to go to in this case on legal proceedings?—The legal proceedings were taken previous to my coming. Of course I cannot say to what amount. I know they had trouble so short a time ago as last August. I think it was then they turned their sewage, their refuse, on to our bacteria beds without giving notice, and choked them, and at that time a legal letter was sent to them about the matter.

12094. In the case of manufacturers making application for permission to connect with the sewers, surely the local authorities have now adequate powers to make conditions and bye-laws?—Possibly they have.

12095. Then the difficulty really arises in connection with those firms that claim a prescriptive right to continue to do what they have for years past done?—I think possibly that may be so.

12096. That is the direction in which you think the local authority should be given greater powers?—I think so, yes.

12097. But are you of opinion that it is possible at all for the law to be so defined as to apply to all cases?—You mean all cases of trade, manufacturers' refuse.

12098. Well, all cases of all variety that arise?—Well, I think that depends upon the kind of refuse that they wish to put into the sewers.

12099. Whatever may be the condition of the law, and whatever modification may be brought about, still cases will have to be considered on their merits?—I think so.

12100. And therefore difficulties between local authorities and manufacturers will have to be arranged, at any rate, on grounds of mutual convenience, with power of appeal to some external body?—I think so.

12101. I was rather interested to find that you had changed your view which you at first expressed of confidence in the Rivers Board as a local authority, and that the ground for the change in your view had been a discovery that on the Rivers Board there were manufacturers who may be supposed to sympathise with manufacturers in these matters?—Yes.

12102. But do you not know that the members of the Rivers Board are selected from the various local authorities, county, and county borough, and borough authorities, and that therefore the local authorities may be considered to be quite as largely represented on those boards as the manufacturers?—Possibly so, yes.

12103. And do you know of your own knowledge or have you heard that these boards, although there may be some manufacturers upon them, have been putting

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very great pressure upon manufacturers throughout the district to purify effluents, and have incurred considerable odium in consequence?—I cannot say that I have, only I though it far better for people who were not interested at all to be on such board.

12104. I do not want to argue the point with you; you are entitled, of course, to your opinion, but I just wanted to point out to you that it might be claimed that the local authorities were equal to, perhaps more largely represented than the manufacturers?—Quite so, yes.

12105. (*Dr. Burn Russell.*) What is the population of your district?—Nearly 15,000; between 14,000 and 15,000.

12106. Are you able to estimate the total trade refuse produced by your district?—The trade refuse is simply in my own district, tannery refuse, which I gave, and slaughterhouses which I am not able to give. There are no other works of any kind, or of any particular kind, that come in to our sewers.

12107. Did you tell us the total dry weather flow of your sewage?—32,000 gallons to the outfall works where the tannery refuse comes. I did not tell you in my reply, because at that time I had not got it. I have since gauged the flow, and the amount is 32,000 gallons to the outfall, in which we take the tannery refuse.

12108. And the tannery refuse amounts to 1,000 gallons?—To 1,000 gallons.

12109. (*Major-General Carey.*) Is the trade effluent in your district admitted into the sewers with the consent of the local authority, or is there a prescriptive right?—As far as I can understand it has always been admitted into the sewers.

12110. And the manufacturers have a claim, or consider they have a claim?—Well, I suppose they consider they have a claim.

12111. At what point do you object when you object to a trade water being admitted; when do you begin to make conditions as to treatment?—When we find out that the trade refuse admitted into the sewer is giving us a lot more trouble than the ordinary domestic sewage. I take it then would be the time to make complaint to the people and get them to do something.

12112. You can always trace the effect in the effluent to the particular trade water?—We can in our case. I do not know that you could do that in all cases, but with regard to our own case we can trace it. There is no getting away from the fact of the smell, and several other matters too.

12113. Then in any future application by manufacturers to admit trade water into the sewers the local authorities would make conditions beforehand?—It would depend what kind of manufactory it was. I take it, if it was likely to give us a lot of trouble and bother with the Rivers Board, no doubt they would try to make arrangements with them.

12114. There is no special contribution at present paid by manufacturers?—No; they simply pay the ordinary rates of the district.

12115. For this treatment of sewage?—For this treatment of sewage; and that is why I consider it is very unfair on the ordinary townspeople.

12116. Are you able to regulate the flow of the trade effluent into your sewers?—I think it is possible to do so; that is what I wish to do.

12117. Is it done in your case?—It is not done at the present time. They simply let it all off in a flush. They send us word at the time they are going to let it off, and it is let off straight away, and runs down in a very short period of time, so that we can keep it quite separate at the outfall works. But, as I stated just now, I think that it would be better if they could distribute it evenly throughout the 24 hours, so long as the volume was not more than 5 per cent.

12118. (*Professor Ramsay.*) Do you know what comparative amount of rates are paid by the tanners and by the people who have slaughterhouses in comparison with the general rates of the town?—I cannot say that I can tell you that; I have nothing to do with the collecting of the rates, and therefore I do not know anything about what amount of property they have. Of course, it all depends on the amount of property that they have in the district. They only pay ordinary rates, the same as other people. The rates are very high in our district, I am sorry to say.

12119. (*Chairman.*) Can you tell me how long any trade refuse has been going into the sewers at Handsworth?—I am sure I cannot tell you that. The works that are now turning their trade effluents in were started somewhere about 1850—I think 1856 or 1857—and whether they have turned it in ever since that time or not I cannot say.

12120. But, at all events, it has been going on long enough for the manufacturers to have acquired prescriptive rights, if such rights can be acquired?—There is one thing about it, if you will pardon my not answering that directly; the present outfall works have not been put down very many years. The tannery refuse, I think, has gone into the old system of sewer ever since they started the works, but the new outfall works, the outfall works that it goes to now, have only been put down about 10 years, I think, if so long as that, and whether that would give them any prescriptive right or not I cannot say.

12121. Oh, no; it was only the question of time I wanted to know about?—They have been there, I believe, ever since the new works were put down.

Mr. ALFRED EVANS FLETCHER, F.I.C., called; and Examined.

Mr. A. E. Fletcher, F.I.C.

12122. (*Chairman.*) You are Mr. Fletcher, late Inspector under the Alkali Act?—I am. I have prepared a short statement. I thought it might save time. I have put down a few things that I thought would be interesting and best for the Committee to know. Shall I read them?

12123. If you would read them we shall be very much obliged?—Until the time of my relinquishing office in 1895 I had been since the year 1884 Chief Inspector under the Alkali, &c., Works Regulation Acts for the United Kingdom and Ireland, also Inspector for Scotland under the Rivers Pollution Prevention Act. Although no inspector was appointed for England under the Rivers Pollution Act, I on several occasions was desired to report on certain cases of rivers pollution, caused by effluent liquors from manufacturing or mining operations, in some cases sitting on Commissions of Inquiry under the Act. The original Alkali Act was passed in 1863, and had reference to alkali works only, and in them only to the hydrochloric acid gas they were liable to discharge into the air. The Act, at first tentative, being passed for five years only, was afterwards made permanent, and by subsequent Acts, passed in the years 1874, 1881, and 1892, was so enlarged as to include nearly all classes of manufacturing processes from which noxious gases were liable to escape. The number of works now under inspection is 1,054, of which 85 only are alkali works. In the earlier Acts definite amounts were named as limits to guide the inspector in his measurements of the amounts of noxious gases found to be escaping. In the case of hydrochloric acid the limit was 5 per cent. of the amount generated at that time, or, as an alternative, 2-10th grain in one cubic foot of the chimney gases; in the case of the exit gases from the sulphuric acid chambers, 4 grains acid per cubic foot. In the Act of 1881, however, a more elastic limit was introduced, in that it was enacted that the best practicable methods must be used to prevent the escape of noxious gases. These Acts have worked satisfactorily throughout, though at first some of the manufacturers looked on the inspector with doubt. The more careful and successful manufacturers, however, soon learnt to welcome the inspector, regarding his visits as a stimulant to their own people, a help in carrying out their own rules. As regards the amount of noxious gases discharged into the air, he maintained a standard which was from time to time advanced as skill and knowledge increased; thus the limit fixed in the Act of 1863 for the amount of hydrochloric acid gas escaping from an alkali works was 5 per cent. of that generated; the average amount of that gas now found to be escaping has been reduced to 1·45 per cent., or, taking another limit for the same gas, that fixed in the Alkali Act of 1881 is 2-10th grain acid per cubic foot of the flue or chimney smoke containing it, but the amount now found to be escaping is on the average 0·089 cubic foot, or less than half the amount fixed by the Act. It is interesting also to notice the commercial value of this educative work as shown by the fact that some materials which once were considered valueless and were allowed to escape as noxious gases into the atmosphere, are now carefully collected, and in some cases are even found to be the most valuable portion of the

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manufacture. Attention should be drawn to the experience gained under the Alkali Act as to the value of the "best methods" clause. In Section 4 of the Alkali Act of 1881 it is enacted that the owner of every work shall use the "best practicable means for preventing the discharge into the atmosphere of all noxious gases evolved in such work." And a similar phrase is employed in Clauses 4 and 5 of the Rivers Pollution Prevention Act of 1876. It may be thought by some that such a clause is less definite than a numerical standard. It will, however, in practice be found that a numerical standard grows out of the clause now quoted. In cases constantly repeated and brought under the observation of those interested, it soon becomes known what are the best practicable means of accomplishing a desired end, and the measure of approach to that end then becomes capable of numerical definition. If, on the other hand, a fixed numerical standard is at any time set up, though it may be suited to the conditions of the moment, yet soon, by the increase of knowledge and skill, or by other change in those conditions, that standard ceases to represent the end aimed at. The "best practicable means" clause, on the other hand, is an elastic band ever maintaining the requisite pressure. Nor can a manufacturer object to it, as his profession will always be that he is doing the best he can under the circumstances of the case. Nor is the work of the inspector diminished if he seek to prosecute, for he must prove to the Court that the best practicable and reasonably available means are not used in the case in question, by showing that under similar conditions a better result is usually attained. It will be noticed that under the Rivers Pollution Prevention Act, 1876, no inspector is appointed to enforce its provisions. The only mention of such an official is in Clause 12, where he is empowered to grant a certificate that in a given case the only practicable and available means for preventing the pollution of a river have been employed. He is not empowered even then to see that the means provided continue to be employed, or to maintain any continued oversight. I think that a resident inspector, having the oversight of certain water areas, into the streams of which polluted liquids are liable to be discharged from mines, factories, or sewage works, if he had power of entry to such premises and of examining the liquids flowing from them, would soon formulate such rules and fix such standards as to the purity of the various effluents which would suit the particular conditions of each several case, and that when necessary such conditions and standards might be brought before a court of jurisdiction and a penalty recovered on their infraction. I have put down a few notes afterwards which I have not extended. Inspectors under the local authorities would probably not be men of equal standing with those appointed by a Government board. My experience in Scotland has been that I was welcomed as an inspector coming from the central authority, because they professed themselves as much more willing to be under such an inspector than under one appointed by the local authorities. A Government inspector is more permanent than one appointed by a local authority, and is more independent of local influence.

12124. When were the alkali inspectors first appointed?—From January 1st, 1864, we date our appointments; the Act was passed in 1863.

12125. And were they appointed in answer to any demand from the country, or as a precaution by Government?—The then Lord Derby brought in the Act in the House of Lords, being painfully aware of the damage done to his own estate and those of neighbouring landowners; they pressed him to bring in the Bill. His estate is within three miles—the boundary of the Knowsley Estate is about three miles from St. Helens, which at that time was the chief centre for the alkali works; most of the alkali manufacture was divided between St. Helens and Newcastle. Widnes was then a smaller place than it is now.

12126. Then it was a request made to the Government; I mean the initiative was taken by the landowners?—By the landowners.

12127. That is to say, by people whose property was suffering?—Quite so.

12128. And then the alkali inspectors were always Government officers from the beginning?—Always; they were under the Board of Trade at first, and afterwards transferred to the Local Government Board.

12129. Did you say that there are now 1,050 works that they inspect?—There are, yes.

12130. And how many inspectors are there?—Nine or ten inspectors and sub-inspectors. They are classed as inspectors and sub-inspectors by the Board, but their duties are the same; they each have a district.

12131. Are they resident in the district?—They are resident in the district, yes.

12132. Then, in a sort of rough way, you may say one inspector or sub-inspector inspects something about 100 works on an average?—Yes, it would work out like that; but there might be a great many more processes. There are many processes in one work often each requiring separate inspection.

12133. The 1,054 works would not be all that they have to inspect; there might be processes in addition to that?—Yes, almost in every one there are two or three processes which would come under his inspection.

12134. The districts are settled by the Local Government Board, I suppose?—Yes, in consultation with the Chief Inspector.

12135. And in your experience inspectors were popular with the manufacturers they inspected, and useful, in fact?—They are.

12136. Do they go regularly round or pay surprise visits?—Their visits are always surprise visits; they have no fixed time for visiting.

12137. And supposing an inspector requires a certain thing to be done, what power carries it out?—The penalties are fixed in the Act; the original penalties are very heavy—£50 for the first offence and £100 for the second breach of the original Alkali Act.

12138. Would the inspector take action himself; the chief inspector?—The chief inspector is the prosecutor.

12139. He would be the prosecutor?—Yes; it is in his name as a personal suit.

12140. (*Professor Ramsay.*) But the expense, of course, does not fall upon the inspector?—No.

12141. It is taken off his shoulders afterwards by the Treasury?—It is in his name, but, of course, the charge is afterwards sent on to the Local Government Board. I am happy to say that the charges never did fall on the Local Government Board; I never lost a case.

12142. But does this fact that the chief inspector having to act as prosecutor not rather make him chary about taking up cases; does it not put him to great trouble and considerable expense?—I do not see that the trouble would be any more if it is in his name than that of some other officer of the Local Government Board; he would always be the active man in the case; under whatever name it was, he must be the active agent.

12143. (*Major-General Carey.*) Can the chief inspector prosecute on his own initiative without the approval of the Board?—Certainly not; with the sanction of the Board.

12144. It has to be formally approved?—He has to get the sanction of the Board, which would be produced in court.

12145. (*Professor Ramsay.*) You were kind enough to send me a pamphlet of Mr. Spence's?—I thought it was very much to the point, and that you would like to see it.

12146. (*Major-General Carey.*) Do the inspectors suggest means for abating the nuisance in making these requirements, or do they merely find out whether a nuisance exists?—Officially they do not; but they very often do help the manufacturer by pointing out evils, and perhaps suggesting means of remedy, on which there is no secrecy. There is no reason why they should not enter into a friendly conversation about it, and help; in fact, it is by convincing a man that he can do better than he is doing that progress is made.

12147. But the manufacturer could not turn round and say, "You have made the requirement; now I have carried that out, and it is a failure," and turn the responsibility on the inspector?—Just so. That is where the inspector has to exercise wisdom in not giving advice; he certainly would give no advice officially, but you asked me, as a matter of fact, whether in friendly conversation suggestions were not made. It was in Scotland I have acted more in connection with the rivers pollution, and there it was often a matter of discussion what should be done; I joined in the discussion as to what they should do, and watched the effect of it.

12148. (*Professor Ramsay.*) Did the Alkali Act and the Rivers Pollution Act vary as regards drainage from

alkali heaps, and did they deal with rivers pollution by means of sewage or any trade effluent?—The Alkali Act does not touch rivers pollution. In one of the subsequent Acts a clause was put in bringing the alkali heaps under inspection, and making the owner of such heap responsible for the nuisance arising from the heap. That nuisance would be, of course, both from the drainage and from gases.

12149. Then water from rivers pollution was also in the domain of the alkali inspectors, was it not?—Rather on account of its nuisance to the air than with regard to any effect on the stream. The smell coming from it was the thing we had to complain of.

12150. Not the actual pollution of the stream?—Not the actual pollution of the stream, no; we had nothing to do with the actual pollution of the stream.

12151. Is that left entirely out of control by the Alkali Act? May an alkali maker, so far as pollution of the stream is concerned, pollute as much as he likes? With reference to the Alkali Act, is there no control and no restraint?—We dealt with the "waste" to see that it was properly laid, we went to the beginning of the matter to see that it was properly laid. You are familiar with the material; if not well beaten together, if at all exposed to the air it very soon heats—in fact, in 24 hours it would begin to heat, and we saw that it was very closely packed all round, so that it should not heat, and this would mitigate the evil of drainage from it; but we had no power to say, "You have polluted this brook, and therefore must stop the drainage."

12151*. Mr. Spence proposes in his paper that an extension of the powers of the alkali inspectors would meet the case, if they were given the power of controlling not only the aerial pollution but the aqueous pollution. That implies the question whether the chief inspector has enough to do at present, whether he could take to other work; it would be either he or someone like him who would take on the rivers pollution?—He has already enough to do.

12152. That is what I was going to ask you; he has plenty to do as it is?—Yes, he has.

12153. It would require another staff?—It would require another staff.

12154. Would you advise dual control or single control; could the staff be increased?—There is an evil in many inspectors going into one work. The manufacturers say, "Well, there is another of you come this morning," and that sounds bad, and therefore as to the attention to any particular work, it is an advantage for the one man to have both to do. In fact, their interests or action might be somewhat clashing. The man who looked after the gases might enforce a system of washing down the gas and getting it into the water, and the other man who looked after the water might say, "Oh, you should let it go up in the air." Of course, there you have a slight confusion and a slight clashing, and therefore on that account you ought to have one man.

12155. It would involve increasing the number of inspectors very largely?—Yes.

12156. Is it your opinion that there should be one head man; that that would be better, so as to have a single control at the head of it all?—I would not like to give an opinion without seeing what Mr. Carpenter, my successor, says about it. I think he feels that he has quite enough to do. I know Dr. Angus-Smith was proud to consider that he had the ruling of the air and the water.

12157. I remember?—But there was nothing done under the Rivers Pollution Act, as you are aware.

12158. (*Major-General Carey.*) When a case is reported to the chief inspector by one of the district inspectors, is it long before action is taken as to a nuisance from an alkali works and a prosecution ensues? what sort of time would elapse before the action is taken by the chief inspector?—I do not think often a prosecution takes place for one individual offence. It was generally when the affair became aggravated, and he ceased eventually to yield to the pressure which was being brought upon him, that a special case had to be taken up. The prosecution would have to rest on a special offence. It was generally one taken out of a number.

12159. That pressure is put upon the manufacturers by threats of prosecution, I suppose?—Yes.

12160. (*Professor Ramsay.*) Any system of interference with sewage would require to be obviously submitted to the Rivers Board; would require it under their control; do you conceive it possible to dovetail a Rivers Board system with an inspection such as that prevailing under the Alkali Act?—I do not, perhaps, quite take the meaning. You would look at the river in the first instance, but you would go back to the special drainage—to the special operation to effect that matter.

12161. You would, of course, but what I mean to say is this—would it be advisable to put each river with the towns and works on it under the control of some separate inspector?—One would think so. The district would be one special watershed, one special river.

12162. The present division of districts does not depend upon that?—No.

12163. Would any re-apportionment of the districts present any great obstacle?—Yes, the districts would be quite different. I think one need not answer that question very definitely. There are many considerations needed in arranging a group of works—railway communication has a great deal to do with it—how an inspector can best get about from works to works and save his time; and as a fact works are grouped together now very much on the banks of rivers, for the sake of getting water from the rivers, or for water carriage; so that there are groups of works now on the rivers, and works do not generally occur in isolated districts, perhaps therefore the same district would do in many cases.

12164. Then it appears to me to be your view that by a suitable increase of inspectors, similar to those under the Alkali Acts, it would be possible to bring the rivers under a similar system?—Yes, the system is eminently adaptable to rivers pollution. The Central Authority, and the influential way in which a Government inspector can enter a works, and the independence of local influence, his permanence, are all to be desired for both kinds of inspection.

12165. You would propose, would you not, to bring sewage works under a system of inspection similar to that at present applied to alkali works?—They would be like other works, of course, subject to inspection.

12166. To pass to another subject, do you think the Commission would be wise in not fixing on a standard, but in merely making this general statement—"the best practicable means"?—I feel very strongly on the value of that method of definition. If two men on opposite sides are viewing the same thing, and have to control, we will say, a certain effluent of water or of gas—it comes to the same thing—and they know very well all the details as to its production and the difficulties attending it, they get to an understanding tacitly between themselves, and they crystallise down to a numerical statement, which it would be impossible, I think, for a central authority to predicate and appoint in all the numberless individual cases which arise. It may be that their definition would rest on the colour of a chemical reaction, or even of smell, a variety of tests have to be applied, and they come to a decision between them. I am thinking of two men on the two sides of the question. As I would say, the numerical standard crystallises out of the other; it does not remain quite as indefinite as it sounds.

12167. I suppose, in fixing an approximate standard of this kind for rivers, it would not be necessary always to use the same standard; the inspectors and manufacturers would come to some sort of agreement as to what is reasonable in each particular case?—That is exactly what I wish to say.

12168. And then the inspector can put on the screw as he finds approximation made to his standard, and suggest something better?—Yes.

12169. Is that done in the case of alkali works; is the screw put on in that way?—The obligation is for a man to use the best practicable means; the prosecutor has to show it if these means have not been used.

12170. Is that not very difficult?—That must vary. A case might arise, for instance, where an apparatus depended upon a continual supply of water, and you go there and find there is no water. It would be a matter of gross carelessness that such a thing should be at all possible. I have taken the case to show that he was not using the best practicable means, for he had got his own apparatus there, but not kept in use—it was quite clear that he was not using the best practicable means.

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12171. I am trying to think how would that work out for sewage problems; supposing a man surreptitiously were not to run his sewage over his filter beds, but ran it away by a side channel?—That would be easily taken up, because he was not purifying that sewage at all.

12172. But that case would not often come up. The general case would be that a man turned his sewage on to his filters and overworks them, or perhaps lets them clog up, or perhaps has not got such good filters as his neighbours; I want to see whether a system of inspection would be possible?—That is the place where the inspector would come in; he would, speaking with figures, say, "Your effluent is represented by such a figure, and you know under other conditions it could be brought down to a much lower figure than that," thus giving the basis of the prosecution.

12173. So it would work?—It works down to figures. I want to show that though the Act may give no numerical standard you soon acquire one. A special drug is found, from a dyework, for instance; you will find in some cases such a substance as chromic acid coming away; it would be impossible, I imagine, for a central authority to predicate in what particular manner that may be allowed to come, and in what quantities. The inspector would have to say, "You can do much better than that," and show them by a little consultation in the laboratory how easily it could be done, then if they get beyond a reasonable limit he would be able to prove to a judge that the best and reasonable means were not taken. It would have reference to the individual substance in that individual case.

12174. (*Chairman.*) Have you had to undertake many prosecutions?—Under the Alkali Act I have undertaken several, probably two or three every year.

12175. And have there been difficult legal points decided in those cases?—I have never lost a prosecution.

12176. You were established entirely under the Act of 1863?—The Act of 1863; we began work in 1864.

12177. Have difficult legal points been raised about prescriptive rights, and so on?—We never had any trouble with prescriptive rights. There was one humorous case—at least it sounds rather humorous—at Sowerby. It did not come to me, but I know it was a defence in the case that that firm had—and they showed by their books that they had always lost in their vitriol chambers 20 to 30 per cent., and therefore claimed that they must be allowed to go on doing so. That, of course, is only a matter of history; now we have no trouble of that kind.

12178. (*Dr. Burn Russell.*) The central authority differs in Scotland from that in England under the Alkali Act?—It is under the Secretary for Scotland.

12179. And in England under the Local Government Board?—For prosecutions in Scotland we had to get the consent of the Secretary for Scotland, and we had to get the consent of the Secretary of the Local Government Board in England, or the Local Government Board in Ireland for a prosecution in Ireland. In every case we had to get the consent of the central authority.

12180. You have one sub-inspector for Scotland?—Yes; he is under the same chief inspector, who is the chief inspector for all the three—in Scotland and Ireland.

12181. Has he a district in Ireland also under him?—No. The Scotch inspector at present does not go to Ireland. He did at one time. The districts were divided then so that he took a part of Scotland and Ireland. Now the inspector in Lancashire goes across to Ireland.

12182. There is a thread of connection already between the administration of the Alkali Act and the Rivers Pollution Act in Scotland, is there not?—The same inspector takes both, yes.

12183. Is it an accidental thing that he should be appointed? It depends on the will of the Secretary for Scotland, I suppose?—The work done under the Rivers Pollution Act in Scotland is uncertain, and may be quite nominal in amount. He is not empowered to set the Act in motion, and therefore he has no stated duties under it. It is only in case of complaint he may be sent by the Secretary for Scotland to report on that individual case.

12184. It is not work of inspection at all; it is merely he is the expert who is asked by the Secretary for Scotland in case of complaint?—Yes, to report to him.

12185. And is there an annual report in that capacity by him?—There is an annual report, yes; I published a small report annually for Scotland.

12186. Addressed to the Secretary for Scotland?—Quite so.

12187. But it merely contains?—A statement of what has been done.

12188. That is a statement of the inspections by order undertaken?—Quite so.

12189. It gives no idea of the extent?—The most important work I had to do was to report on the condition of Loch Long. A deposit of sewage dredgings from Glasgow were brought, as you may remember, to the entrance of Loch Long, and I reported on that case.

12190. But you went there because of complaints made to the Secretary for Scotland, and sent by him?—Quite so.

12191. You had no initiative in the matter at all?—No.

12192. (*Colonel Harding.*) Of the 1,054 that you spoke to us about as being under the control of the chief inspector, are the great bulk of the works alkali works?—I gave the numbers, sir; 54, I think it is, only alkali works out of that number. The rest have been added to the work of the inspectors since the original Act.

12193. Then what is the scope of the Alkali Act; does it include all the works that turn out evil gases?

12194. Specific classes of works?—Specific classes of works. I gave those numbers in order to show that the working of the Act had been thought sufficiently successful that these accretions have come to it.

12195. That the Act had been expanded?—The Act had been extended.

12196. The Act is not sufficiently large to take in the control of many works that take in obnoxious gas, is it?—No, one would think that the Act ought to have been called the Noxious Gases Act—instead of that it is called the Alkali Act. They have to look out for the acid in alkali works.

12197. The question of smoke, of the gases produced by the combustion of coal or oil or wood, are excluded from the operation of the Act?—Expressly excluded.

12198. And would the stink, for instance, from a candle works come within the scope of the work?—No, candle works are not mentioned in the Act.

12199. I should be very much interested to know from you whether inspectors take the responsibility of advising manufacturers who are producing noxious gases within the scope of that Act, and as to what course they should take to prevent the pollution of the air. Do they just take the responsibility of saying: "This is what you should do," or do they simply say to the manufacturer: "You must stop this pollution in such a way as you think fit"?—They very carefully avoid giving advice officially; it would destroy their influence.

12200. What course do they follow; do they say: "We notify you that you are polluting the air, and you must stop the pollution?—The course I always followed was, with respect to the gases from an alkali works—the hydro-chloric acid gas—I should say in particular that is defined as 2-10ths of a grain, I would make the usual test of gases going away, and find perhaps on a certain occasion it exceeded that. I would go to the chemist in the laboratory and say: "You are over the mark to-day. How is this? What is wrong? Come and take a test with me." I would make him go with me, and we would repeat the test together. He would make his test and I would make mine.

12201. But the point I want to get at is this: Do your inspectors give to the manufacturer an opinion as to the process, the best practicable means then known, which he should carry out as far as possible to stop this pollution?—No, certainly not, no advice is given specially. It might be a matter of increasing the apparatus if the figures had shown that the condensation was not sufficient, and the remark might pass: "You will have to put down more condensing plant." Such advice as that might be given.

12202. The responsibility of finding the best practicable means rests with the manufacturer?—Entirely.

12203. You do not lay down what are the best practicable means?—Certainly not. Speaking only of the results.

12204. But you are probably ready enough through the inspection to give information to the manufacturers

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where the best practicable means can be seen in operation?—Where such things were common property. We have to be extremely careful not to give information from work to work, but most of them, especially those things concerning the sanitary part of the business, are held to be common property.

12205. But in the event of a prosecution. Let me assume for a moment that you are prosecuting a firm for turning out too large a proportion of noxious gas. Then you would have, would you not, to satisfy the court that there are practicable means for doing better?—Yes.

12206. You would probably have to give evidence, and specify where this practicable means could be seen in operation?—I should confine myself, as far as possible, to speaking of the result. A good instance would be the vapours or artificial manure decomposition of superphosphates. We had no figure there to guide us at all, but I have conducted prosecutions against the works for not condensing those fumes properly. If I should come along the road and smell those works half a mile distant, that would be the beginning of evidence, that they were obviously not condensing properly. If I came and found a figure very far in excess of what was usually found, even in those same works, and then found the water distribution was very ineffective, I could easily point out that the whole thing was being conducted, in a very slovenly manner; that would be sufficient for me to go by.

12207. But the main point which you give me is that the inspectors do not take the responsibility of telling the manufacturers what the process should be that they should adopt to attain the result desired?—Quite so. It is often a very small one. "Wash and be clean"; that is to say, apply plenty of condensing water. Of course, one would tell them, "You must have more condensing plant here." That would be giving advice in a certain way.

12208. Well, what we find in connection with rivers pollution to be a great difficulty is this: the manufacturer says, "First of all you do not lay down a standard, and, secondly, you do not tell us what you expect us to do. Now, if you would tell us that you would be satisfied with such-and-such a thing, and if you would say that this is the way in which we want you to carry out your work so as to bring about that result, we would be willing to incur the necessary expense to do it. But you do not tell us," says the manufacturer, "what we shall do; you leave it entirely to us to discover. Now you have probably the information we can only get at with great difficulty, why do you not give us this information? Why do you not tell us what we shall do?" That is one of the difficulties in the way of River Boards. I was wondering how you had met it in connection with the administration of the Alkali Act?—I can give you an instance with regard to rivers pollution which, perhaps, touches that point exactly. It was a mine in Westmorland. There is an effluent from the mine—a mine where they raised lead and zinc ores, and the effluent was destructive to the fish, and people did not seem to know what to do; they were, in fact, going on quite a wrong tact. Evidently it really wanted a little lime being put in the liquor, which settled the zinc and caused a very good effluent. I made a few experiments myself, and I told people what to do, and they adopted it, and it was very successful. My advice was given purely as a friend.

12209. Well, suppose they had carried out what you had advised, and it had not been successful, would there not have been a claim on the part of the manufacturer—"Well, we have done what you told"?—He was still guilty of killing the fish.

12210. You cannot ask us to do any more?—It would not absolve him from the fact, if he killed the fish, if he had done something to palpably pollute the stream; but I was only giving you an instance where I gave friendly advice, which was accepted. A chemist can hardly abstain, in a certain way, from saying, "You can do better than that; you might easily do so and so." These are casual relations, which pass between chemist and chemist, without being of any binding nature. I gave that as an instance where I did give them definite advice, but unofficial and experimental only.

12211. (*Professor Ramsay.*) Would it not be possible to put it in this way; the inspector might say, after making his complaint, and pointing out what was wrong, "Now I have given you my actual opinion, and now, if you like to have any advice, I shall give it you as a friend; but you must take the responsibility of taking this advice and putting it in practice; if it does not succeed, you must not blame me"?—Obviously, it would always be put in that form.

12212. (*Colonel Harding.*) Your experience in connection with air pollutions is that it is much better to leave with the manufacturer the responsibility of finding out for himself what is the best practicable process?—Certainly.

11213. You think that it is unwise for the inspector to take upon himself the responsibility of advising, except with the restrictions which have just now been pointed out, that he is advising as a friend, and takes no responsibility as to the result?—Certainly, it would never do for an official to give advice formally.

12214. It has been suggested, nevertheless, that a rivers authority supervising large districts would accumulate a vast amount of experience and information, and, having that in its possession, might properly impart it to the manufacturer, and say, "This is at present the best practicable means of dealing with this particular form of nuisance; apply that, and we shall be satisfied." That is a suggestion which has been made to the Rivers Board?—It is a very dangerous position to take up. Many find great fault with the Local Government Board, now, I suppose, for insisting on a certain method of dealing with sewage, while other people may think they have a better or a different plain.

12215. The difficulty is when they have carried out what they have been advised to do. It is difficult to call upon them to do anything if that fails?—Quite so; besides these matters, if they are in the hands of the local authority, are public property, and have been described in papers read before several societies, and are well known.

12216. It is then for the inspector simply, without taking any responsibility, to call the attention of manufacturers to published documents or to existing knowledge open to manufacturers?—I think he only has to attend to the result; he has to point out that the effluent is bad; he knows himself that it might be improved; if he is certain that it cannot be improved he would modify his style of complaint.

12217. Have you found, in connection with your experience of the Alkali Acts, that the best practicable means—means which, I suppose, have been developed and improved—have been by the development of some already known process, or by the substitution of some entirely different process. I mean this, that manufacturers sometimes say, in connection with rivers pollution: "You pointed out that the best practicable means at present known was so and so, and we put that down, and no sooner had we put that down, and you come and say, 'Here is another practicable means which is better still'; and it is quite different, and it makes useless the expenditure we have incurred, and therefore we hesitate to spend anything"?—Would it not be open for an inspector, in the case of a works where they carried on a certain precipitation method, and with very indifferent results, and he compared those with what was done by altogether another kind of treatment; he would say to the people: "Now, this effluent is very bad; you know they do it much better in other ways; you really must look to it and improve this." He knowing very well that it can be improved, it is not necessary for him to point out how it is to be improved.

12218. (*Professor Ramsay.*) But he might tell them where the better process is being carried out?—He might say that certainly; he might easily, in case of irrigation works.

12219. (*Major-General Carey.*) Why are the inspectors popular with the manufacturers—because they give them advice unofficially?—They are popular with the better class of manufacturers. Shortly before our appointment some of the manufacturers at Widnes were complained of very much by the farmers round about, and they were on the point of engaging someone to come, and, in fact, they did engage Sir Henry Roscoe at that time to come and make an inspection of their works, in order that they might have an answer to give the farmers; so that the manufacturers might be able to say: "Here is an independent man who comes to our works when he likes, and you see he says we are doing our duty." They were actually appointing an inspector for themselves in order that they might be able to say that they were right, believing, of course, that they were right.

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12220. They were employing an inspector to defend themselves?—Yes, quite so, and since we were appointed, I remember, at St. Helens, they were in the habit of sending a sum or sums every year to the farmers round; you might call it "blackmail"; some might say it was fair compensation; I do not want to enter into that question, but they ceased to pay it when we were appointed. They said: "You see we are under Government control; you cannot complain of us." I am only saying those are reasons why they should look upon us as friends—wisely or not—but they believed that we were helping them to improve their works.

12221. (*Colonel Harding.*) Just one final question I should like to ask you as the result of your experience under the Alkali Acts; you have found that at relatively small cost to the public you have been able to bring about a large reduction of air pollution, and that without seriously interfering with the carrying on of manufacturing?—Quite so, even with benefit to the manufacturer.

12222. (*Dr. Burn. Russell.*) You are aware of Dr. Ballard's report to the Local Government Board on offensive trades?—Yes.

12223. Very important reports they are?—Yes.

12224. Well, you speak of the better class of manufacturer that you were popular with; the better class of manufacturer. I suppose it is the case that there are always individuals among producers of nuisance who affect to be perfectly helpless as to the remedy, who know nothing about this wretched Act, who say, if you attempt to interfere with them, that you will crush their trade and ruin the country?—Yes.

12225. The effect of Ballard's reports was that it always put it in the power of officials such as I used to be in Glasgow to say, "Now it is no use talking in this sort of way; there is exactly the same sort of business carried on in such a place without the slightest offence"?—Quite so.

12226. That made an end to that argument?—Quite so.

12227. And you would in a similar way accumulate a mass of experience which would be useful to all the producers of offensive effluents in the country?—Quite so.

12228-9. So that without absolutely prescribing a definite cure in each case this would become, as I think you said, common property of the whole trade?—Quite

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Mr. THOMAS CARTER BEELEY, J.P., called in; and Examined.

12230. (*Chairman.*) You are Mr. T. Carter Beeley, Mayor of Hyde?—Yes, my Lord.

12231. Do you admit manufacturers' refuse into your sewers?—We do; all liquid refuse. We have not any regulations at all forbidding anything to go in.

12232. And what are the kinds of refuse and what is the volume of the refuse as compared with the volume of ordinary sewage?—We have from cotton mills some size which very occasionally contains chemicals—not very often. Chemicals are not much used with us; we have no heavy cloths; and, of course, the ordinary sanitary refuse. Then we have felt hat works; a large number of them. They send us washings and dyes which carry fluff with them. Then we have the water from the hat planking, which is slightly acidulated. We have the waste colours from aniline dyes chiefly. We get logwood vats emptied, perhaps, once a month on the average. And the wool washings (we have a few hats made from wool), they carry soap and grease and a little soda ash as well. We have engineering works from which we get domestic sewage only. We have got indiarubber works that give us their waste from the reduction process, and the vulcanising, which contains bi-sulphide of carbon, and we get naphtha occasionally in the sewers from it. We have cork works, making cork soles for boots. From there we get domestic sewage only. We have raising and finishing works and bleach works giving waste liquids from the processes, some dyes (aniline dyes only), and some starch and bleach. The largest bleach works is separately treated. It is below the level of our outfall works, and it has never been delivered into the sewers. From box-making we get in very small quantities flour paste, glue, and glue substitutes. From printing—we have two large printing establishments—we get rubbings from the preparation of the lithographic stones only. Then we get the butchers' refuse; that is, from the killing. We get the contents of the entrails and that sort of thing, and blood as well, and the tripe-dressers give us animal fats and washings. Then we have a large margarine works belonging to Otto Mönsted; they give us animal fats only; they are skimmed in a rather rapidly flowing tank, which was the best that could be done in the space at disposal. I should like to say that when we let off our open septic tank after 14 months' working for the first time we had just about as much sludge in the bottom of the tank as we should have had in a week under chemical precipitation. That is about 11 tons, and we found it impossible to press it; it was so full of concentrated grease that it made up the pores in the jute cloths and made them impervious to water altogether; we could not force it through. We got cakes in the first three or four layers of the press, beyond that we could not get any good from them at all. We attribute that, of course (the majority of it, at any rate) to the margarine works, and to the butchers and tripe-dressers' refuse and fats.

12233. (*Colonel Harding.*) Would it have any fuel value for you?—I do not think so, sir. To tell you the truth, we buried it. We have emptied the tank three times since then, and we have tried each time to press it again separately, and we found it impossible. Well, we got on a little better by using a great deal more lime. We were not able to do it at anything like a reasonable cost, and so we simply buried it. We thought you would very likely know that we have got sanction for £23,000 for extensions on the Whittaker and Bryant system, and it is our intention to try to burn it afterwards in the destructors. We have the destructors on the same premises as the sewage works, and we are trying to raise all the steam from our refuse, for pumping the water to spread it over the filters, and we were intending to try to burn it afterwards as a means of getting rid of it.

12234. (*Chairman.*) What is the total flow of your trade refuse?—I have been trying to get at it, but I have altogether failed. There does not seem to have been any record kept. I have only been chairman of this Committee for about six years now, and there does not seem to have been any record kept of the quantity. I have been round to the various works since I got the questions, and tried to get it for myself, and one man will say: "Well, we empty a vat perhaps once a month; there is 300 or 400 gallons; then there is all the washing water in addition." You ask them what all the washing water is; they do not seem to be able to tell you at all, so I have been quite unable to get really any adequate idea of what the comparative flow is. but in the evidence that was sent up previously for our town I think it was stated at about 25,000 gallons, and that was as near as we could come to it. I do not mean to imply that it is an entirely reliable estimate, but it is as near as we could get.

12235. Have you the least notion what proportion that would be as compared with the domestic sewage?—No, because we have nearly all the surface water comes into the same drains from the town as well.

12236. Assuming it to be somewhere about 25,000 gallons, it would be only a small proportion?—It would be only a small proportion.

12237. And you find that the admixture of trade refuse materially increases the difficulty of treating the sewage, apart, that is, from necessitating an increase in the size of the works?—Very materially, as shown by comparison of our raw sewage analysis with that of an ordinary domestic sewage. The strength of the sewage requires more efficient treatment, and hence it is more costly to treat this sewage than domestic sewage; the difficulty is increased by the fact of the total flow being small. The total flow does not exceed 30 gallons per head, including the manufacturers' effluent and the surface water of greater part of the town.

12238. Does the difficulty arise more from the condition or kind of the refuse or from its volume?—From its condition, and the fact that the flow of it is intermittent, and that the ingredients mixing make products in the sewers, which are sometimes more difficult to deal with than the ingredients themselves. The character of this sewage has been dealt with before

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your Commission by Mr. Scudder in his details of the experimental filters at Hyde.

12239. You have not adopted any regulations for the admittance of trade refuse into your sewers?—We have none.

12240. Do you consider that a local authority should be empowered to construct sewers for trade refuse alone?—Well, speaking only from my own experience of our town, I do not think such a course necessary. We have a very varied and concentrated sewage, and for nearly three years we have been dealing with one-twentieth of the daily flow, under the supervision of Mr. Scudder.

12241. (*Colonel Harding.*) By what process?—By the Whittaker and Bryant process.

12242. Following after septic tank treatment?—Yes; an open septic tank, and allowing 24 hours to travel through, and then a Whittaker and Bryant filter.

12243. And with what result?—With very few exceptions, after the first three months' working, they have been declared by Mr. Scudder, who is our advising engineer, and who is the man who condemns us when we are before the Courts for rivers pollution—declared to be fit to be turned into any stream.

12244. And that, notwithstanding the presence of any of these trade effluents?—Yes, and, notwithstanding the fact that in some cases we have absorbed quite a grain and a half of oxygen, whereas the Mersey and Irwell standard is a grain. If a separate sewer was to be put in for manufacturers' effluents, the cost in a small town like Hyde should be paid by the traders necessitating it. As it has been shown that it can be treated with the general effluent, I think such a tax on the industries should not be imposed by the corporation.

12245. (*Chairman.*) Are the positions and rights of the manufacturers and local authorities under the existing law clearly defined?—Well, my town clerk has suggested a reply which, perhaps, I had better read. As far as my own personal opinion goes, there seems to be a great want of defining. What it all really means we have not been able to find out properly. "The positions and rights of manufacturers and local authorities under the existing laws are not very clearly defined. Under the Rivers Pollution Prevention Act, 1876, local authorities are compelled to give facilities to enable manufacturers to carry liquids from their own works or processes into sewers, except in following cases:—(1) Where liquid prejudicially affects sewers; (2) where it prejudicially affects disposal by sale, application to land, or otherwise of sewage matter; (3) where injurious from sanitary point of view; (4) where sewers only sufficient for requirements of district; (5) where the introduction of the liquid would interfere with the carrying out by the local authority of the order of a court of competent jurisdiction."

12246. Should the law be altered, so as to give manufacturers greater rights than at present, to connect up with sewers?—Not altered, more clearly defined as to what they really are.

12247. If greater rights were given to the manufacturers, are any further safeguards required to secure that the refuse shall be delivered in such a condition and in such regular quantities as not to interfere with the purification of the sewage?—Well, I consider that there should be a condition allowing local authorities to demand that settling tanks should be put down where possible of the capacity of the daily flow of each manufactory, but compulsorily of six hours' capacity, that these should be regularly cleaned, and that the effluent should be regularly distributed for at least 12 hours daily by means of a floating arm, so that the vats of dye or reducing vats from rubber works, etc., could be put into the sewers regularly, and spread over as large a period of time as possible. Power should be had to place screens at all inlets to such tanks for the removal of waste, fur, fluff, or other solid matter likely to choke the filters. Such tanks would not, of course, apply to the domestic refuse of such manufactories.

12248. And how should such further safeguards be enforced?—Well, I think an Act of Parliament necessary to enable local authorities to alter existing connections, and to make new connections on the lines suggested. Such an Act would, I think, be generally desirable. In an omnibus bill in preparation for Hyde, we are seeking powers named on No. 8 (12247).

12249. In this omnibus bill that you speak of, are you trying to provide that the manufacturers should be bound to carry out all these additional safeguards that you have mentioned?—We are asking that they should be bound to provide a tank to accommodate, at least, a six hours' flow of their effluent. Wherever it is possible it should be the whole daily flow, but compulsorily six hours.

12250. For each manufacturer?—Yes.

12251. Can you tell us how long ago it is since manufacturers began to use your sewers for their refuse?—Well, I really could not.

12252. A long time ago?—A long time ago.

12253. Then, if there are such things as prescriptive rights, your manufacturers have already got them?—They have already got them, and that is why I suggest that an Act of Parliament would be necessary to enable us to alter existing conditions.

12254. You would take away, by this Act of Parliament any prescriptive rights that they might have?—Yes, unless they complied with the conditions that I have named in 12,247; they must comply with these or be disconnected.

12255. Do you find that the manufacturers are willing to adopt the means for the removal of suspended solids, grease, etc., from their trade refuse before discharging it into the sewer?—Representatives of all the manufacturers in Hyde, including the butchers and tripe-dressers, and excepting only one indiarubber manufacturer, met my Sewage Works Committee, and agreed to put down tanks such as I have suggested, to the drawings of our surveyor, on condition that we remove the refuse from these tanks when cleaned out. The manufacturers were apparently very desirous to assist the town authorities in this work. I should like to add there are already boxes with fine gauze screens through which they run their effluent with the view of taking out the fluff and fur, and several of the tripe-dressers since that meeting have put down tanks to catch the grease, as well as they can under the present circumstances.

12256. Have you agreed to remove the refuse?—I have; well, I have given an undertaking on behalf of the corporation, when the manufacturers' representatives agreed that they would help us by putting down the tanks, I agreed, on behalf of the corporation, that we would remove the refuse for them, we would collect it.

12257. Have you made any rough estimate of what the cost to you will be of removing that refuse?—No; it cannot be very great though, because you would not require to empty them as a general rule very often, and the average tank, I do not think, would put out more than a cartload of refuse at once in cleaning.

12258. Should you say that there ought to be some tribunal other than ordinary courts of law, such, *e.g.*, as a Central Government Rivers Board, to whom appeal could be made when a local authority refuse to allow trade refuse to go into the sewers?—If an Act of Parliament, such as I have suggested was passed, there would be no necessity for such a thing as a Central Government Rivers Board, and no other tribunal other than the local Courts would be necessary. In my mind, a Central Government Rivers Board would be likely to add to the present difficulties of the local authorities by having a tendency to extend its functions and impose new standards of purity, when those exacted by the present Rivers Board are sufficiently arduous already in small communities, which depend on manufacturers for their existence.

12259. Should manufacturers be required to pay a special rate or charge in those cases where they are allowed to connect with the sewers. If so, how would you suggest that the amount should be determined?—I do not think so; they are usually large ratepayers, and small towns, at any rate, must encourage trade in the town rather than hamper it at all. If they will take the precaution suggested in No. 8 (12247) I do not think that any other restrictions need be placed upon any manufacturers, with a possible exception of rubber works and chemical works, and the waste liquor from galvanising processes. The evidence given before your Board has, I think, proved conclusively that the general trade effluents of the town can be dealt with. If it should be decided that it is best that each manufacturer should treat his own, or, if exceptions, such as are suggested above, are made, I think that such manufacturers should be exempt from, at any rate, a portion of the sewage rate.

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12260. What are the reasons generally advanced by local authorities for refusing to allow trade refuse to go into the sewers?—In the case of hot solutions causing damage to the earthenware sewer pipes, and volatilising the noxious gases of the sewage and the creation of a public nuisance. In the case of chemicals, the cause is the difficulty of dealing with the mixed sewage at the outfall works.

12261. What would be the effect upon the flow of the water in the streams in those cases in which the manufacturer uses the water from the stream in his manufactory if the trade refuse were delivered into the public sewers?—I do not know whether I have understood the question as you intended it. I have assumed that, after treatment, the water would be returned to the same stream. Of course, I know of a case, not far from us, where there is water taken from one stream, and, after it has gone through the sewage treatment, it is put into another stream altogether, although the two join at some considerable distance further down. But, viewing it in the light that they would be returned into the same stream, I do not think there would be any alteration in the flow. It would, however, result in a distinct improvement of the stream (such as are in this district) if all manufacturers' refuse went into the public sewers, and consequent treatment. Our own river, particularly, I should like to add, is very largely used by manufacturers, and all sorts of stuff comes down it; it changes its colour almost hourly, and it is really practically, more or less, an open sewer.

12262. Would any alteration in the law be desirable to get over the difficulties connected with riparian rights?—We have not had any difficulty with riparian owners. I do not think riparian owners should be able to sustain any claim against a local authority in respect of their turning the effluent from a sewage works into the stream, provided, I should like to add, that that local authority is putting in an effluent that is satisfactory to the governing Rivers Board.

12263. (*Colonel Harding.*) Just one question. You foresee no difficulty in regard to applications to connect with your sewer where new manufactories are put down. You have ample powers to make the necessary conditions, have you not?—Well, I think that there is quite sufficient laid down in the present laws, that would, at any rate, allow us to make a good fight for it.

12264. The only difficulty is in the case of those who have been long connected, and you think there that further powers should be given to the local authorities?—I think further powers are necessary for that.

12265. Then you foresee that even in case, even if you had a local Act, it would be necessary to appeal to some Court where differences arise?—Yes.

12266. When you speak to us of your preference for local Courts, do you mean the magistrate's Court or the County Court?—The magistrate's Court or the County Court.

12267. Would you have confidence in appealing to the Local Rivers Board, in your case, I suppose, the Mersey and Irwell?—Oh, I should have confidence in appealing to the Mersey and Irwell Rivers Board.

12268. (*Dr. Burn Russell.*) In the case of those bleach works which discharge their effluent below the sewer level is the treament carried out by you or by the proprietors?—By the proprietors.

12269. At their own cost, I suppose?—Yes; they have settling tanks. I do not think they have anything beyond settling tanks.

12270. And ultimately where does it go away from them?—It goes into the stream, into the River Thame. They are under the Mersey and Irwell Board also, and they have lately been making extensions, by direction of the Board, to their works.

12271. Is there any consideration given to these manufacturers in respect of rates at all?—There is not at present. I say in my evidence that I think there ought to be, because it seems to me distinctly unjust that we should ask them to pay the whole rate when they get really no advantage for a certain proportion of the rate.

12272. Do you treat all your sewage now by the septic tank system and contact beds?—We are making the alterations; we are now at work making the alterations; we are spending altogether on the necessary alterations to the destructors and to the new works £23,000.

12273. On the occasions when you emptied the septic tank and got rid of the sludge, did you notice any impairment of the septic process following upon that?—No; we kept on each occasion three or four barrels full of the wet sludge, and when we cleaned out the tank we shut down the valves, let it fill again, and put this in.

12274. As a sort of yeast?—Yes, to give it a start again. We have taken samples within three or four days at the outside, and they have not shown that there was any cessation of the efficiency of the tank.

12275. (*Major-General Carey.*) How about the abstraction of water from the river, when the manufacturer obtains the water from the river for manufacturing purposes, and delivers the effluent into the sewers, and thence to the outfall, which may be some considerable distance below the works, perhaps a mile; would there not be a very serious effect upon the quantity of water in the river?—Well, presuming it was all taken out at one point, and that the whole of the mile between it would have an effect, but works which are taking water from the stream, with us are spread along the banks of the stream, the whole distance practically, right up to our own sewage works.

12276. That may be; of course, that is rather unusual, is it not, to have the works spread along a long distance like your sewage works? Even then the outfall may be a considerable distance below your sewage works?—Oh! Yes, it might be. In that case, of course, it would make a difference if there was a sufficient quantity taken out, but the Thame is a river which has usually a fairly good supply of water. There is compensation water coming into it from the reservoirs of the Ashton and Staleybridge Joint Water Works Board, and as well as that there are a number of small streams going into it, and in the driest summer it is very rarely that there is not sufficient water for condensing purposes for all the mills on the banks. Of course, I cannot speak from experience of what would be the effect on a small stream of taking all the water out.

FORTY-FIRST DAY.

Tuesday, 1st *July* 1902.

PRESENT:

SIR MICHAEL FOSTER, K.C.B., F.R.S., M.P. (*Chairman*).

Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Mr. W. H. POWER, F.R.S.
Colonel T. W. HARDING.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary*.

Mr. S. S. PLATT, M.INST.C.E. (Borough Engineer of Rochdale) and Mr. THOMAS STENHOUSE, F.I.C., F.C.S. (Public Analyst of Rochdale), called; and Examined.

Mr. S. S. Platt, M.INST.C.E. and Mr. T. Stenhouse, F.I.C., F.C.S.

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12277. (*Chairman.*) You are, Mr. Platt, the Borough Surveyor of Rochdale?—(*Mr. Platt.*) I am, Sir.

12278. And you are Mr. Stenhouse, the Public Analyst of Rochdale?—(*Mr. Stenhouse.*) Yes.

12279. Do you admit manufacturing refuse into your sewers?—(*Mr. Platt.*) Yes, there is some manufacturers' refuse discharged into the sewers of the Corporation.

12280. What is the volume of the refuse compared with the volume of the ordinary sewage?—About 100,000 gallons per working day of 12 hours, compared with 1,500,000 gallons in the same period.

12281. In the same period—in 12 hours?—Yes, equal to a proportion of about one-fifteenth.

12282. And what is the nature of the refuse?—Wool scouring.

12283. Tanneries?—Fellmongering—tanneries, leather works—that is currying, soap works, rubber recovering works, sizeing, and grease works, tripe boiling, and small quantity of dye water.

12284. And, quite apart from the question of the increase in the volume of your sewage, do you find great difficulty in treating your sewage after the refuse has been added to it?—That is so on account of the intermittent flow and the character and condition of the refuse.

12285. There are two things, are there not; one is the intermittence of the flow?—That is so, sir.

12286. That is a very serious difficulty?—Yes, that is one of our greatest difficulties.

12287. The other is the nature of the refuse which interferes with the ordinary purification of sewage?—That is so, sir.

12288. That in your case is a less evil than the intermittence of the flow?—Well, they are both difficulties on account of the character. If I may be allowed to say, sir, the intermittency of flow applies more particularly to this particular trade refuse that is of such a bad quality, say, for instance, wool scouring; i.e., the suds from wool-scouring becks; they not only send such bad stuff, but they send it so irregularly.

12289. But I mean, supposing arrangements were made so that there was a regular flow of this refuse into your sewers, would you still find that the difficulties of treating your sewage were materially increased?—We would.

12290. (*Sir William Ramsay.*) You say in your statement that 100,000 gallons come in for 12 hours; I suppose that means 100,000 gallons come in during 24 hours?—No, sir; I tried to make it clear—100,000 gallons during a working day of 12 hours.

12291. Then there is no flow during the night?—Oh, no, nothing to speak of.

12292. So that really means 100,000 gallons during 24 hours if it were evenly distributed?—There would be no more during the 24 hours, but it really all comes in 12 hours.

12293. (*Chairman.*) But if so it would form part of the 2,250,000 which come in in the 24 hours?—That is so.

12294. Is the refuse at all treated before it reaches your sewage?—Well, some of them put down very small subsiding tanks, but they are very little good, because it is passed through at such a rate, as a rule, that there is a very large amount of solids comes away, and we cannot be always at their works to see that they clean them out. There is a tendency to flush them in our direction. There is something done. Some manufacturers who gave us a great deal of trouble have done some little towards subsidising, but they do not go to the extent of providing sufficient tank capacity to really give it the chance of subsiding during the whole of the day.

12295. And then is the amount of grease large; do you find that that is a great trouble?—That is one of our greatest troubles; it comes away like froth and scum; frothy scum floats down on the top of the sewage. It comes intermittently, and then it is in such a fine state of division that it will not precipitate.

12296. How do you treat your sewage?—In precipitation tanks principally with alumino ferric.

12297. And nothing more; it is simply precipitation, or have you any subsequent process?—Well, we have about 60 acres of filtration plots of land, intermittent filtration really, but during the last 18 months or two years we have not been able to do much on this land. It has got so sewage sick that we have had to throw it out of use, and at the present time we are going all over this land subsoiling it.

12298. Meanwhile you are discharging your sewage simply purified by precipitation with alumino ferric?—That is so.

12299. Into what do you discharge?—Into the River Roch, which is a tributary of the Irwell. We are within the jurisdiction of Mersey and Irwell Joint Committee. We have had an experimental plant going for about two and a-half years, which your officers have had an opportunity of seeing several times.

12300. Is your purification satisfactory?—To the Joint Committee?

12301. Yes?—No, sir; but, of course, they know the position we are in. My Corporation have always been very wishful to meet all the reasonable requirements of the committee, and the fact is that we have been rather too previous. Other towns have been doing nothing, and we have been—well, since 1888—doing our best to treat this; but the difficulties have grown upon us, and, in fact, it has spoiled this land, and we have spent a tremendous lot of money, for this is the main tributary. We took in a district last year with another small sewage works, but as far as Rochdale, as it was prior to 1900 we had spent over £70,000, with a population of over 70,000—practically £1 a head—and could not give satisfaction even then on account of the difficulties with the manufacturers' refuse. We find, of course, at the week end, when it is normal sewage, that we have no difficulty at all.

12302. (*Mr. Power.*) Do you attribute the difficulty of the land mainly to the grease in the sewage?—Yes, sir.

12303. Do not manufacturers recover their grease?—Not all; very few.

12304. Do many of them?—Well, a few recover a certain portion of it, but the stuff they send down is bad enough.

12305. (*Chairman.*) Those who have recovered a certain portion send very bad stuff down?—That is so.

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12306. (*Major-General Carey.*) Do you consider that chemical precipitation with land treatment would have been sufficient for your ordinary sewage if the manufacturers' refuse had not been admitted?—For ordinary sewage, yes, I think it would.

12307. Absolutely?—Yes, I think it would.

12308. Has the manufacturers' refuse always been admitted into the sewers?—Yes, it has been long before the Rivers Pollution Act; some are very old connections which they have got. Of course, the sewers were discharged into the river then.

12309. If a new factory started, would they get into the sewers?—Only on conditions.

12310. On conditions of treatment?—They must do some preliminary treatment.

12311. (*Chairman.*) But that applies to very few of the cases or to a large number?—Well, there are three or four, but there is one that practically sends half the volume down, 50,000 gallons a day.

12312. And that is purified before it reaches you?—That is purified as far as they can do it reasonably.

12313. To your satisfaction?—Well, I do not know that we have anything to grumble at.

12314. Then, roughly speaking, what is the proportion of trade refuse which is purified to that which is not purified?—About half and half.

12315. And that half is still giving you a large amount of trouble?—Yes, it comes so intermittently. The half that is treated is treated with alumino ferric, and passed through tanks and subsides a considerable amount of the solids and, of course, the effluent is coming off uniformly throughout the day. If they would all do that we should have very much less trouble. Instead of that there are smaller manufacturers, but the quality of their stuff is very bad; it comes in flushes.

12316. And they are old manufacturers who have, so to speak, a vested interest?—Yes, acquired.

12317. (*Sir William Ramsay.*) Could the smaller manufacturers not be induced to copy the larger?—There are always the difficulties that they have not the land to do it with, and it is so in many cases; for instance, I have one in my mind now, where the works were fixed alongside of the river because of the water rights and all that sort of thing in the days when there was no thought of river pollution or any necessity to do anything to meet the difficulty. They would practically have to remove that portion of their business somewhere else where they could get land. Well they say, when I suggest it to them, "That interferes with our business; no, we cannot do it"?

12318. (*Colonel Harding.*) And they say they cannot even carry out your desire to have a regular flow?—Not from a precipitating tank.

12319. Can they not do that much?—No, because they say there is no room on their premises.

12320. What is the volume of their flow?—About 7,000 to 10,000 gallons a day.

12321. What is the size of the tank they would require to store it?—Well, say about 1,000 cubic feet.

12322. It would be something quite small, would it not?—I have pressed them a good deal about it, because we do not want to be awkward with manufacturers; we do not want to harass them in any way.

12323. But surely a storage tank which would allow a steady flow spread over the 24 hours for the particular firm would be so small a matter that if you called their attention to the size of the tank that would be required you would get it done, would you not?—I have done that.

12324. You think the law should be strengthened to give you greater power in these cases?—Yes, I do, sir.

12325. You have no difficulty in the case where application is made to you to connect; the difficulty is simply with those who claim prescriptive rights?—That is so exactly; we have had no difficulties with any who want to come in; we have not imposed any unreasonable conditions, and they have fallen in with them; and I will say they have fairly observed them. We take samples when we think fit without giving them any intimation, and we have had no reason to complain of the way they have met us.

12326. (*Chairman.*) Then, in your opinion, the relative positions and rights of manufacturers and local authorities are not adequately defined under the existing law?—No, I do not think they are. I think it is unfair altogether that a manufacturer already in should have a preference over a manufacturer who wants to come in; in fact, it is a very serious complaint with some of our manufacturers. They say, "Here, we want to come in; you ask us to do this. Why do you not ask others to do it engaged in the same trade? You handicap us for a start," and I think it is not an unreasonable position to take up.

12327. (*Major-General Carey.*) You never will be able, apparently, to produce a satisfactory effluent until the trade effluent is treated independently of the sewage?—Well, I think it would be a great deal better if sufficient preliminary treatment could be done at each works. It could be done for a mere trifle compared with what it costs us. When it has got mixed with 2,250,000 gallons of sewage it is a very difficult thing to deal with it, but if they deal with it at their works it is easier, because they know the quality of the stuff they are dealing with, and they could neutralise it to a large extent and make it so that the flow into our sewer would be of reasonable quality.

12328. (*Chairman.*) Do you think that the law should be so altered as to give you a right to insist upon that?—I do, sir.

12329. Even where they have prescriptive rights?—I do, sir; I do not think they have any right to put that stuff down to us in that way; give them reasonable facilities.

12330. Then in return do you think that the manufacturers should have greater rights than at present to connect up with sewers, on the supposition that they treat their refuse in an adequate manner before it is thrown into the sewer?—Well, I do not know what greater rights they can have. There is one point that I would like to say should not be lost sight of, that is in regard to water abstracted from streams. I do not think that a manufacturer who abstracts water from streams for a manufacturing purpose should have any right whatever to put it into our sewer and get rid of it in that way. He ought to be made to restore it in a satisfactory condition to that river. I have several manufacturers in our borough in my mind that if they could do that it would almost deplete the stream; some of them use 100,000 or 200,000 gallons a day. The result would be that if they put it into our sewer it would flow two and a-half miles before it would get into the river again; and when our sewage scheme was under consideration in 1879 there was a very strong point made by the manufacturers that as far as possible all water should be returned, and, in fact, that we should have storm overflows, and get as much water into the river higher up, so as to prevent it all being taken down to the outfall works, and really diverted from the stream. In manufacturing districts it is a very important matter.

12331. Are there any other safeguards, do you think, required to secure that the refuse shall be delivered in such a condition and in such regular quantities as not to interfere with the purification of the sewage?—Well, I think there ought to be something done in regard to the quality and condition of the effluent that passes into the sewer, and also as to the regularity of its flow and the reducing of the solids to a reasonable quantity.

12332. You think it would be possible to lay down definite regulations. Of course, with regard to the regular flow there would be no difficulty, but to lay down general regulations with regard to the amount of purification which the refuse should undergo before it was received into your sewers?—No, I do not see that there should be any difficulty if there was a reasonable standard put to which they could attain and which could be enforced.

12333. What would be the general lines of those standards; that all solids would be settled, I suppose?—Yes, as far as possible.

12334. Then with regard to the reaction of the fluid, I suppose it should be neither excessively alkaline nor excessively acid?—That is so. That is one of the great difficulties.

12335. And that it should be as free as possible from grease?—Yes, sir.

12336. And those conditions satisfied, then you think the refuse might without difficulty be thrown into your sewer?—Yes, subject, of course, to not allowing

it into the sewer when it ought to go back to the river.

12337. (*Mr. Power.*) Do your manufacturers draw mainly from the river, or do they use Corporation water, or do they get water from private sources?—Well, all ways, sir. There are some take it from the river, some from wells, and some from the Corporation. Of course, if they take it from the Corporation I should not say that the restriction applied that they ought to return it to the river; decidedly not; in fact, I should only insist upon it being returned to the river when it had been taken from the river. I could not say that the other ought to go back, but put it in a reasonable condition, so that we could take it into the sewers and let it come in.

12338. (*Chairman.*) I gather from what you said that in regard to those manufacturers who have not hitherto been connected with your sewer, you find no very great difficulty in compelling them or in inducing them to treat their sewage before you receive it?—No, sir, we do not.

12339. But the chief difficulty is with those who hold prescriptive rights of discharging?—That is so. A firm makes an application to us; well, I go and see the place and get samples of their liquid, form an idea what it is in quantity, and so on; then I say to my committee, "Well, I think so and so and so should be done." "Well," they say, "we are willing to take it on those terms." "Very well, we will agree." The course that has been adopted in our case is a County Court order. Where we agree as to the terms, we then go to the County Court Judge and get an order that these are the terms upon which the facilities should be allowed.

12340. And are you satisfied with that mode of procedure?—Well, we have had no difficulty so far.

12341. You are not of opinion that there would be any advantage in having some more general tribunal to which such cases might be brought?—Not in the cases supposing the parties can agree, but if the parties do not agree I do not know what course would have to be adopted, unless they took steps to enforce our giving facilities.

12342. But if the parties do not agree it is open for them to go to an ordinary court of law; is that a satisfactory way of settling the difficulties?—In a court of law?

12343. Yes?—No, I do not think it is.

12344. You would be in favour, then, of some tribunal to whom the case should be brought, and their judgment should be accepted as final?—Yes, I think it would be better; there would be probably more uniform treatment.

12345. Such as a Central Government Rivers Board, central for the whole of the kingdom for instance?—The only difficulty that I can see about that, sir, is this—whether such a board would have regard to the varying conditions, say, between manufacturing towns and towns in very rural districts, where a higher state of purity of the river might be necessitated.

12346. But surely it would be the duty of such a tribunal to make themselves fully acquainted with all those various conditions, and to deliver judgment accordingly?—Under these circumstances I think it would be better.

12347. Do you see any advantage in manufacturers being required to pay a special rate or charge in the cases where they are allowed to connect with sewers?—Well, I do not see any objection to it, if they will do it; but my idea is that there would be very great difficulty in this way, that they would not quietly agree to pay such an amount or such a charge commensurate with the difficulties that they cause. If they would spend considerably less than that money at their own works in preliminary treatment, it would be a great deal cheaper for them and better for us.

12348. What do you find to be the reasons generally advanced by local authorities for refusing to allow trade refuse to go into the sewers?—Well, the increased difficulties and expense in the treatment of sewage mixed with trade effluent. It becomes a very serious question.

12349. In speaking just now about the withdrawing of waters from the streams, do you think that any alteration of the law is desirable?—No, I do not, sir; I do not see why. Well, it would become a very great hardship, in my opinion. The manufacturer has planted his works on the banks of a stream in expectation of the water supply; in fact, it is the very thing that has induced him to do it, and if you go and suddenly alter the law and deprive him of his riparian rights I do not know where he would be.

12350. (*Sir William Ramsay.*) Do your manufacturers pay a large share of the rates?—Oh, yes; but then there are large manufacturers who do not cause us any trouble at all; that is another anomaly. Here is one particular trade sends its refuse, which is really a residuary product from their works, into the sewers, and causes the general ratepayers to have to incur considerable expense; but we have had cotton mills which cost perhaps £100,000 or £150,000 that do not cost us any expense. They do not even ask us to take their ashes away, and you would think that they had equal rights with the other people. If it is liquid it can be sent into the sewer, but if it is solid in the way of ashes or any waste material like that, they have to deal with it themselves.

12351. They are large ratepayers?—Very large ratepayers; they are contributing to the cost of another industry.

12352. (*Major-General Carey.*) There are cases in which manufacturers have no land on which they could treat their manufacturing refuse before entering the sewer?—There are some; I have mentioned a few.

12353. In those cases what would you suggest if they are unwilling to treat their effluent before it goes into the sewer?—I think it could be done; for instance, it could be pumped up to a tank, say, and if there is a difficulty about land they might make some arrangement whereby it could be considerably improved. They raise objection, as they say they have no facilities; they have no land to spare to do it, but if they were forced to they would find some.

12354. They would find the means?—They would find some means.

12355. (*Chairman.*) Have you anything you would like to bring before the Commission, Mr. Stenhouse, in addition to what Mr. Platt has told us?—(*Mr. Stenhouse.*) Yes, I have got a few things; I have not sent you a copy of what I have to say, but it will not take me five minutes to go through this memorandum, and then you can ask me any questions.

12356. Thank you; if you will go through it?—I have put down that our average raw sewage contains about 60 grains per gallon of total solid matters, of which 21 grains (35 per cent.) are in suspension. I would suggest that manufacturers' refuse-liquids ought not to contain more than 20 grains of suspended solids, or that the liquids should stand for 12 hours to allow the solid matters to subside, and only the supernatent liquids be admitted to the sewers.

12357. That supernatent liquid containing again not more than 20 grains; that is your standard?—Not more than 20 grains unless they have allowed this liquid to stand so long.

12358. The point would be the condition of the refuse when it was discharged into your sewers, would it not?—Yes, it might be worse than usual; for instance, some refuse will not allow the solids to subside readily; some are in a fine state of division, and remain in suspension. I think a manufacturer does all he can be expected to do if he lets that liquid stand a reasonable time.

12359. (*Mr. Power.*) You would be content if he did let it stand a reasonable time?—Yes, that is only a reasonable request.

12360. Whatever the result of it was?—Yes.

12361. (*Chairman.*) You would not apply a numerical standard, then?—Not if he allowed it to stand 12 hours, and I think in all these works that Mr. Platt has mentioned there would not be difficulty in finding room for that subsidence, and then allowing the liquid to flow regularly during the day.

12362. Provided that they allowed the material to subside for a certain time, you would be satisfied with that result?—Yes.

12363. (*Mr. Power.*) Twenty-four hours' storage you think most of them could find room for?—I think they could; but I would certainly insist upon a 12 hours' standing of this refuse, so that solid matters could go down, and not be sent into the sewers. (*Mr. Platt.*) An absolute quiescence for 12 hours. (*Mr. Stenhouse.*) Standing in some tank or cistern, without any agitation or fresh inflow.

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12364. (*Chairman.*) Or fresh inflow?—Yes; your fresh inflow would rouse the matter up, or agitate things.

12365. (*Mr. Power.*) Then you would make the manufacturers cleanse their tanks periodically?—Oh, yes; draw off those tanks.

12366. The authority would not undertake that?—No.

12367. If they let these tanks go uncleansed there would be a great deal of suspended matter coming over; they want attention, would they not?—That sediment would want treating, or mixing with ashes from the boilers, and carting away.

12368. They themselves would have to do it?—Yes, because if any of these works has a solid refuse they have to go to the expense of disposing of it—carting it away.

12369. You would have it on the same lines; the sediment from their tanks, that they would have to get rid of at their own expense? — Yes. Average raw sewage at Rochdale yields about 0·76 grain of albuminoid ammonia, and the oxygen absorbed in four hours at laboratory temperatures is generally between 5 and 6 grains per gallon.

12370. (*Chairman.*) That is your mixed sewage?—That is our mixed sewage.

12371. Domestic sewage and the trade refuse which falls into it?—Yes, as it comes at present. The raw sewage, however, often varies greatly, chiefly owing to manufacturers' refuse being discharged into the sewers intermittently. Daily tests carried on for some time showed that the oxygen absorbed by the raw sewage in four hours varied between 2½ and 18 grains, that the chlorine varied between 4 and 48 grains, and the alkalinity—calculated to lime—varied between 3 and 23 grains per gallon. At Rochdale the raw sewage is always alkaline. So far as has been ascertained, all trade refuse liquids in the borough are alkaline with the exception of the refuse from a rubber-recovery works. Here the refuse liquid contained, besides much suspended matter, more than 800 grains of free hydrochloric acid per gallon, the total solids amounting to 4,100 grains. Other trade refuse liquids recently examined contained between 400 and 8,000 grains of solid matter.

ALUMINOFERRIC TREATMENT.

TYPICAL RESULTS of Analysis of Raw Sewage and Tanks-Effluent (Grains per Gallon.)

———	Raw Sewage. *	Tanks' Effluent. *
Total solid matters (dried at 100° C.)	60·8	46·6
Matters in suspension	21·0	5·5
Combined chlorine	7·7	6·2
Alkalinity expressed as lime	8·1	5·5
Oxygen absorbed in four hours	5·80	2·85
Free or saline ammonia	1·84	1·81
Albuminoid ammonia	0·76	0·33
Percentage of purification, judged by oxygen test	—	52 per cent.

BACTERIAL TREATMENT.

TYPICAL RESULTS of Analysis of Raw Sewage and Effluents from Septic Tank and Bacteria Beds (Grains per Gallon.)

———	Raw Sewage.	After Septic Tank.	After Bacteria Beds.
Total solid matters (dried at 100° C.)	60·8	49·5	51·0
Matters in suspension	21·0	8·0	5·3
Combined chlorine	7·7	7·5	7·2
Alkalinity expressed as lime	8·1	7·7	1·7
Oxygen absorbed in four hours	5·80	3·51	1·05
Free or saline ammonia	1·84	1·57	0·04
Albuminoid ammonia	0.76	0·49	0·12
Nitrogen as nitrates	—	—	0·99
Percentage of purification as judged by oxygen results	—	39·5 per cent.	82 per cent.

* *See* foot note on page 74.

The alkalinity of these varied between 22 and 520 grains per gallon, the alkalinity being calculated to lime. The chlorine varied between 24 and 220 grains, and the oxygen absorbed in four hours between 18 and 117 grains per gallon. These trade effluents come from soap works, fellmongers', woolscourers', paper-stainers', animal-size works, and tanneries. In some cases these liquids show wasteful management, as, for instance, when strong solutions of chloride of zinc and caustic soda have been found running into the sewers, etc.,

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and I have got—and can show—a sample of these effluents just as they were caught, and you will see for yourselves that there is some of the raw sewage that has been changed in colour by the soapy mixture discharged from a soapworks (*samples produced*).

12372. That is, to say, the raw domestic sewage?—(*Mr. Platt.*) That is the sewage.

12373. Mixed with domestic sewage and the trade refuse?—(*Mr. Stenhouse.*) Yes. Here is a sample containing 4,000 grains per gallon, from the rubber works. That contains the acid I have spoken of, and here is a sample of trade refuse from a soap works that contains a large amount of common salt and tissue from the fat used; that is the water underneath, the salt that was run away—that contains over 8 000 grains per gallon.

12374. (*Sir Wm. Ramsay.*) Is it alkaline salt water?—Common salt.

12375. (*Chairman.*) What does the solid matter consist of?—Common salt and tissue and caustic soda.

12376. What tissue?—Skin tissue from the fat and grease used in the soap making.

12377. (*Sir William Ramsay.*) And that, I suppose, is the salt liquor?—That underneath is the salt liquor which is run straight into the sewers.

12378. But do they not recover their salt?—They were doing nothing of the kind then.

12379. They lose the glycerine, too, of course?—Yes, unless they are prevented they will go on sending that.

12380. They suffer a great loss by not recovering it?—Yes; as I have said, it is wasteful.

12381. Is it a large soap works?—Well, it is the largest we have in our district; it is not like Sunlight.

12382. But still fairly large?—Fairly large.—(*Mr.*

12383. (*Mr. Stafford.*) Is this taken before it enters the sewer or afterwards (*showing samples*)?—That is just as it enters the sewage works from the main sewer. The quantity of soapy matter is so large that it really changes the whole sewage to that condition. (*Mr. Platt.*) That is as it came into the works.

12384. This is in the sewer?—Yes.

12385. And yet the volume spread over the 24 hours would be quite unimportant, would it not?—I believe it would; but they rush that in at once to get a tank emptied.

12386. And accordingly it causes a difficulty?—Of course it does.

12387. It would not arise if it were spread over?—No, because we could adapt our chemicals to the regular flow, but when it comes intermittently everything is upset.

12388. (*Mr. Power.*) Is the particular manufactory in proximity to the outflow works in your case, or is it at some distance?—Oh, it is half a mile away. (*Mr. Stenhouse.*) We can at once see that somebody is discharging something. It will change from a dark colour to a white soapy mixture, and be strongly alkaline.

12389. (*Chairman.*) You are speaking now of the contents of the main sewer?—Yes, now I am. A tank-full rushed down from some works—probably through a four-inch pipe—into the sewer——

12390. Into the main sewer?—Into the main sewer, will change it completely, both in colour and quality. (*Mr. Platt.*) It is absolutely impossible to deal with that.

12391. (*Major-General Carey.*) What percentage of the total sewage is it; have you any percentage of it?—No; it depends how rapidly it is rushed in, and what quantity they have been storing.

12392. (*Chairman.*) What is the average flow in your main sewer?—(*Mr. Stenhouse.*) Mr. Platt said about one-fifteenth.

12393. What is your average flow through your main sewer?—At the rate of 2,000,000 gallons. (*Mr. Platt.*) You are referring to the special mixture.

12394. Yes?—The average flow in that sewer is about 180,000 gallons a day.

12395. In the 24 hours?—Well, the average flow from that works is about 2,500 gallons per day, but they might send 10,000 to-day and none to-morrow.

12396. And they may be discharging their refuse just at the period when the natural flow of the sewage is at its minimum?—That is very often what they do when they think we are not about.

12397. (*Mr. Stafford.*) Have you ever tested this after it has been flowing for 12 hours?—(*Mr. Stenhouse.*) No, I have not.

12398. (*Mr. Power.*) You did not mention, I think, the variation in the albuminoid ammonia in the raw sewage; have you made a note of it?—The raw sewage?

12399. The raw sewage, I do not think you mentioned the range of albuminoid ammonia?—Yes; I have already stated how a variation in the trade effluents causes the raw sewage to vary.

12400. Yes, it was antecedent to your commencing to speak of the trade effluent that you referred to it?—The raw sewage, however, often varies greatly, chiefly owing to manufacturers' refuse being discharged into the sewers intermittently. Daily tests, carried on for some time, show that the oxygen absorbed by the raw sewage in four hours varies between $2\frac{1}{2}$ and 18 grains, that the chlorine varied between 4 and 48 grains, and that the alkalinity—calculated to lime—varied between 3 and 23 grains per gallon, and I may say that the total solids have varied from about 50 to 150 grains; that is on taking hourly samples and testing them, the quantity of total solids in the raw sewage at one time might be found to be 160 or 170 grains per gallon, at another time not more than 40 or 50.

12401. (*Major-General Carey.*) At night?—Or early morning.

12402. (*Mr. Power.*) Yes; then you gave us the albuminoid ammonia as ·76 as the average, but you have not given us the range of it; have you got it under varying conditions?—Oh, yes, the albuminoid ammonia would vary between ·4 and probably 1·4.

12403. (*Chairman.*) What are your other points, Mr. Stenhouse?—Well, there is this: Of the Rochdale sewage nine-tenths is at present treated with alumino-ferric, and then allowed to flow through tanks. In this way about 50 per cent. of purification takes place, no land or other filtration being employed. For $2\frac{1}{2}$ years one-tenth of the sewage—about 200,000 gallons daily—has been purified bacterially. In this treatment there is one open septic tank, and two coke beds (each 9 feet thick), over which the septically treated sewage is sprinkled by revolving perforated arms.

12404. Continuous filtration?—Yes. By this method a purification of 82 per cent. on the original raw sewage takes place. Those coke beds also continue to reduce greatly the alkalinity of the sewage passing through them. Sulphur compounds in the coke are oxidised, and afterwards neutralise alkaline matters in the sewage, these coke beds reducing the alkalinity to 1 or 2 grains per gallon, although the raw sewage going on those beds might represent an alkalinity of 10 or 12 grains per gallon, the alkalinity calculated to lime.

12405. One-tenth of the sewage treated on these bacteria beds?—Yes, 1-10th.

12406. That is a fair sample of your sewage with the trade refuse?—Yes, everything, sir. (*Mr. Platt.*) Except perhaps the grosser solids, like grit and that sort of thing. (*Mr. Stenhouse.*) The grit deposits in a septic tank.

12406*. Do I gather that the trade refuse then in your sewage does not materially interfere with the efficiency of your bacterial beds?—It does not appear to have interfered at all, but these beds are exceptionally thick or deep, 9ft. deep, and very costly, but they produce a wonderful change, and produce a good effluent by the bacterial treatment.

12407. May we infer that if the whole of your sewage were treated by these bacterial beds you really would not have any great difficulty with the trade refuse?—We should not, but it would be very expensive to do it, to put down those 9ft.-thick beds to treat in this way 400 gallons passing per square yard in 24 hours.

12408. (*Colonel Harding.*) Do you think that the good results you have obtained from your beds with this mixture of domestic sewage and trade refuse may be due to the fact that you have as a first process septic tanks, which septic tanks have probably a capacity of 24 hours supply, and therefore they do give you the uniformity which you have been desiring?—Yes. (*Mr. Platt.*) That is just what they do? (*Mr. Stenhouse.*) Undoubtedly the septic tank does give that uniformity.

12409. Your difficulty at Rochdale, it would seem, is due not so much to the great volume of the trade

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effluent that is turned into your sewers, but to the intermittency of relatively small amounts. There seem to be two courses for you to deal with this difficulty. One is to get a manufacturer to put down a storage tank and let it off regularly over the 24 hours, and in view of the smallness of the volume it seems so very easy for him to do it, that the Commission is rather surprised to find you have not been able to induce the manufacturers to do it. You told us, for instance, about this case, and I think I understood you to say that in your view, 2,000 gallons per day was the output from that?—(*Mr. Platt.*) The average 2,500.

12410. Well, a storage tank for that volume would only require a tank about twice the size of the table at which you are sitting, and there ought not to be any great difficulty in getting the manufacturers to provide that, but failing the provision by the manufacturers of storage tanks, could you not overcome the difficulty by adopting a septic treatment for the whole of your sewage, and so obtaining on the larger scale what you are obtaining on the smaller scale in your experiment with the bacteria beds?—(*Mr. Stenhouse.*) The objection to that would be the great expense. The manufacturer who sends that soapy mixture in is really taking steps to put down a large tank to hold everything and allow solids to subside, and send the remainder in uniformly. It only requires a little pressure to be brought upon them; the manufacturers must see that it is very reasonable to expect them to send their liquids uniformly into the sewers, instead of rushing them.

12411. In the evidence that has come before us generally, manufacturers have been willing to do that?—(*Mr. Platt.*) They are as a rule.

12412. We are rather surprised that your enlightened manufacturers at Rochdale have not done so much?—Others have done it; others have promised to do it as soon as it is shown to them that they are sending in this. When they have been taken, when we have shown them what they are sending in, and show samples of what we have taken from the drains, and they have been threatened with some sort of prosecution, they say, "Give us a litle time, and we will construct tanks to allow solids to subside, and run the other in regularly"; they seem to be willing to do it.

12413. (*Chairman.*) Then is there any other point you wish to bring before the Committee, Mr. Stenhouse?—(*Mr. Stenhouse.*) I was just going to show samples obtained by this method of purification. This is from the septic tank before it goes on to the coke beds, and that is the final liquid—a very pure effluent. (*Samples shown.*) In this case there is a purification of 82 per cent. on the original raw sewage. These coke beds also continue to reduce greatly the alkalinity of the sewage passing through them. The resulting effluent contains between 5 and 7 grains of solid matters in suspension. These, however, quickly subside on the effluent being allowed to flow through a small settling-tank. The effluent, after being kept for a week, remains free from smell. I have got here representative or typical results of analysis of our raw sewage and tank effluent, and also of the same raw sewage after septic tank and after bacteria beds treatment.

12414. (*Mr. Power.*) A chemical analysis?—Yes, just typical results. (*Mr. Platt.*) I should just like to supplement Mr. Stenhouse's remarks. He has referred to the bacterial treatment; it is quite true that these bacteria beds to a large extent remove the difficulty; it is a question of considerable cost, although our existing works are capable of being utilised without any material alteration.

12415. (*Chairman.*) You mean your land?—No, sir, the works, the tanks and buildings, and so on to the extension of this bacterial treatment, but it would mean that for our borough we should have to raise the capital cost for our sewage works alone from about £80,000 to about £140,000, or a matter of about £1 15s. per head. Well, I do not think that would be a necessity to the same extent if these trade effluents were out.

12416. (*Mr. Power.*) Would it involve pumping the sewage then?—It would.

12417. Get the sewage on to the filters?—We have to do that now. To make the matter perfectly clear, these beds are on the Whittaker and Bryant principle, about which you know, but it means all the sewage would have to be pumped, and then the requirements of the Local Government Board that we must deal with three times the flow and so on, brings the cost up to another £60,000 at least.

12418. (*Chairman.*) Your view is that if the trade refuse could be efficiently treated in the manner you have suggested, you are of opinion that your land treatment might be continued?—Yes, probably supplemented with some contact beds, or something like that.

12419. And that would be at an expense far less than that of these suggested bacteria beds?—That is my idea. There is just one point, if I may be allowed, that you did not ask me about, that was about connecting these works to a separate sewer.

12420. May I ask you what is your view about that?—Well, my view is it is prohibitive in price.

12421. On account of the scattered condition of the works?—On account of the scattered condition of the works it is a very serious thing. I do not know that there is anything else.

Note.—Since the above evidence was given it has been found that a quantity of water from the River Roche was gaining access to the main outfall sewer, and consequently diluting the sewage during the period over which the analyses were made.

This influx of comparatively pure water having been stopped, the analytical results since obtained during ten weeks of summer weather, show that the raw sewage averages nearly 40 per cent. fouler than the above tables indicate. The bacterial treatment, however, continues to be as efficient as before, but the effluent from the ordinary tank-treatment is much worse.

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Mr. E. Ll. Morgan, A.M.I.C.E., Borough Engineer, and Mr. James Ashton, F.C.S., F.I.S.E., Works Manager, Bolton, called in; and Examined.

12422. (*Chairman.*) You are the borough engineer of Bolton?—(*Mr. Ll. Morgan.*) I am.

12423. You, Mr. Ashton, are the chemist and manager of the whole of the sewage works?—(*Mr. Ashton.*) Of the whole of the sewage works. (*Mr. Ll. Morgan.*) We have the Hacken Sewage Works and the Rhodes Farm. Mr. Ashton is the manager of the whole of the works.

12424. You admit manufacturers' refuse into your sewers?—Yes, manufacturers' refuse is admitted.

12425. What is the volume of such refuse compared to the volume of the ordinary domestic sewage?—We have about 5,500,000 gallons of sewage, that is, taking the whole during the 24 hours. Of that about 3,746,000 gallons is domestic sewage, and 1,750,000 trade refuse. The domestic sewage, of course, is calculated from the water consumption; the trade refuse is from their own water supplies, from streams and from wells.

12426. May I ask what is the proportion of water which is drawn from streams to that which is drawn from wells and that which is drawn from other sources; for instance, is there any corporation water used by these?—There is corporation water, but I am not in a position to give you particulars.

12427. Is it largely from streams or largely from corporation water and wells?—It is largely from streams for this reason, the sites of these works are generally upon the banks of a stream.

12428. And, of course, their water has to be returned back into the stream somewhere?—Yes, in some cases; but 1,750,000 gallons come into the sewers.

12429. Then what is the character of the trade refuse which is discharged into large sewers?—We have brewery, tannery, tar distillers, bleachers—a large proportion is the bleachers' refuse.

12430. Then you have in the first place as elements of the refuse solid matter?—Yes.

12431. Not a great deal of solid matter; generally is there a large quantity of solid matter?—(*Mr. Ashton.*) Yes, sir

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12432. And a large quantity of grease?—Well, not a very large quantity of grease.

12433. And acid or alkali?—Well, the tanners chiefly, their refuse is either alkaline or acid, for the simple reason that they do not empty both their tanks at one time. If they did empty their lime pit at the same time as their tan pits, the one would neutralise the other.

12433*. But they empty now one and now the other?—Yes.

12434. So that at one moment you have an excess of alkali and at another moment an excess of acid?—That is so.

12435. I suppose there are two difficulties you meet with with regard to the treatment of this refuse—one is that the flow is intermittent, that it is not regular?—(*Mr. Ll. Morgan.*) That is so.

12436. And the other is due to the chemical elements of the sewage?—That is so.

12437. Which is the more serious difficulty, do you think?—(*Mr. Ashton.*) Well, the variation in the flow does create a serious difficulty with the chemical precipitation. You may have a certain quantity of precipitant at one hour which has a very good effect; the next hour the same quantity has no effect at all.

12438. Then let me ask you what is the method which you adopt in treating your sewage?—The chemicals used.

12439. Broadly speaking, what is the system you adopt?—Chemical precipitation.

12440. And nothing more?—And land filtration.

12441. What amount of land have you?—160 acres.

12442. Is that good suitable land—do you find it efficient?—There is only 130 acres available, and about 100 acres of that is very good gravelly land chiefly.

12443. Is your treatment on the whole satisfactory?—Of the portion that we filter, but we cannot filter it all, we have not a sufficient area.

12444. What do you do with that which you do not throw on to the land?—We throw it into the river from the tanks after chemical precipitation.

12445. And that is thrown in an unsatisfactory condition?—Yes, sir. (*Mr. Ll. Morgan.*) May I say, sir, here, that in the reply which has been sent to the Commission, we have given a normal flow of about 5,500,000 gallons a day; our tank capacity at the present time is about 4,000,000 gallons, I think. (*Mr. Ashton.*) That is so. (*Mr. Ll. Morgan.*) So that really we are handicapped very considerably in the treatment of the sewage, but extensions are now in hand, so that really our treatment from the fact of our tank capacity being small, has not been so effectual as it might have been.

12446. Even when you have at your works accommodation, you still find difficulty in treating the refuse?—We undoubtedly find difficulty in treating trade refuse. In Bolton we have a considerable number of connections of long standing; they were connections made really before the Corporation took a serious view of the trade refuse or the treatment of the trade refuse. Recently we have had applications for connections with tanneries. We are prepared to allow the tanners to connect, but on condition that they lay down works. Then they throw the onus of suggesting what the works should be on the Corporation, the responsibility of which the Corporation are not prepared to accept.

12447. That is to say, you are not prepared to state what treatment should be undergone at the works before you are prepared to receive it into your sewers?—Quite so; unfortunately, the Local Government Board take the same view with the local authorities. If application is made to the Local Government Board for borrowing powers, and if they are not satisfied with the scheme they will not sanction the borrowing. The onus of suggesting an alternative scheme is thrown on the Corporation.

12448. Is it not in your power to state that such and such a treatment of the trade refuse will enable you to treat it with the rest of your sewage in a satisfactory manner?—Yes, we could do that.

12449. For instance, if you demand that there should be an adequate settling; if you demand that the flow should be regular; if you demand that there should be no great marked excess either of acidity or alkalinity, and that there should be no very large quantity of grease?—(*Mr. Ashton.*) I have made a note on that, sir.

12450. What is it you have to state to us?—It is in regard to Questions 7 and 8. The safeguards necessary for the delivery of trades refuse into sewers so as not to interfere with the treatment, are: (1) The adoption of quiescent settling tanks of sufficient capacity to hold 12 hours flow, the "solids" to be removed as often as found necessary; and (2) the even distribution of the tank effluent into the sewers throughout a 24 hours day. By all means as many solids as possible should be retained on the works of the manufacturer. I do not consider, however, that there should be any hard and fast lines as to the admittance of trade refuse into sewers, for is it not by these manufacturers that the prosperity of a town depends? The objectionable colour of tan and dye refuse is chiefly organic matter (except where analine dyes are used), and this colour can be effectively removed by passing through a ripe "septic tank." This I have found from actual practice. And I strongly recommend what I call an equalising tank, which is really a septic tank, in all cases where trades refuse of any large volume has to be treated along with sewage matter.

12451. For the whole of your sewage?—(*Mr. Ll. Morgan.*) Yes, an equalising tank, so as to get a general average of the domestic and the trade refuse. (*Mr. Ashton.*) In all cases where trade refuse of any large volume has to be treated along with sewage matter. I think that is quite practical, sir.

12452. These are the demands that you think should be exacted?—Yes, sir.

12453. And you find difficulty in exacting those demands?—Yes; we have no power at all at present to exact those demands.

12454. You cannot admit them into your sewers unless they fulfil those demands?—Well, no, I do not think we have any local Act to this effect at all. I think the Public Health Act and the Rivers Pollution Act would cover us.

12455. (*Colonel Harding.*) Surely you have ample power to make conditions in the case of new applications for connection with the sewers?—Yes.

12456. Your only difficulty is in the case of those who have been connected for many years?—That is the difficulty, sir; that is the difficulty we have to contend with. Take the case of the tannery, the proprietors say they are prepared to do something if we suggest a scheme.

12457. I do not quite appreciate your difficulties. The Chairman just now was putting to you certain obvious conditions that you might lay down, and I understood the manager of your works to say, that in effect you had laid down those conditions; what more is required of you?—Supposing we suggest a method of treatment, and in the course of a few months they found out that they could manufacture in a different way, or tan in a different way?

12458. Well, but if you put it to them that you expect them to settle solids, they do not expect you to say what kind of tank they should put down for the purpose of settling solids?—Yes, they want us to suggest the scheme.

12459. That is going too far?—In fact, they want us to get out a scheme for them; say this is our scheme, and that is what you have to do.

12460. (*Sir William Ramsay.*) And accept the responsibility for the scheme?—And accept the responsibility for the scheme.

12461. (*Colonel Harding.*) I understand, then, that failing any possibility of arrangement with these manufacturers who have been connected all along, you see your way to accomplish satisfactory results by a septic store tank?—An equalising tank.

12462. An equalising tank for the whole mixture?—That is so.

12463. So the difficulty can be met in that way; it is merely a question of expense?—Yes, if the manufacturers will meet the corporation or the corporation will meet the manufacturers.

12464. But the equalising tank which has been referred to will probably do away with the necessity for the manufacturer doing so much?—It may, but when you consider that we have 3,750,000 gallons of domestic sewage, and 1,500,000 gallons is the trade

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refuse. I think it is rather a large proportion. (*Mr. Ashton.*) Yes, it is so.

12465. So if you had your equalising tank you still think you would have to call upon the manufacturer to settle his solids?—(*Mr. E. Ll. Morgan.*) I think so. We have practically half as much trade refuse as domestic sewage; I think as much as possible should be done in the manufacturers' works.

12466. Then, finally, we may take it that you do not see any difficulty in effectively treating the mixture of trade effluents and domestic refuse, provided certain conditions are carried out by the manufacturers, and provided your corporation is willing to have a sufficiently large area of settling tank for dealing with its sewage at the sewage disposal works?—I see no difficulty whatever, sir, provided we can have power to enter upon the works at any time and take samples, and exercise control over their own sewage works—the manufacturers' sewage works.

12467. Has it occured to you that it would be simpler to make it a condition that there should be a manhole, where you could get the necessary samples without going into the manufacturers' works. They object to people coming in and walking about the works, but if there is a suitable manhole where you can see what is passing that would meet the case probably, would it not?—That would meet the case.

12468. We have evidence before us that that is done in many cases?—It is done in this large tanyard that we have.

12469. (*Chairman.*) The difficulty really seems to be that you and the manufacturers cannot agree in the exact way in which it should be done?—The real difficulty is that, as I said before, our trade refuse practically amounts to 50 per cent. of our whole sewage, and a tank is run off, perhaps, a tank that ought to be run off intermittently throughout the day, the whole of it run off in half an hour, and the quality and the character of the sewage varies in a matter of minutes.

12470. But surely there is no difficulty, is there; it would be a very plain thing for you to insist that there should be storage tanks in each of these works, so that the inflow into your sewage should be regular?—Yes, quite so; there is no difficulty.

12471. You have got to insist upon that, and I mean there is no legal point—no recondite legal point—involved in it?—No, except in view of the old connections; manufacturers are not prepared to remove the old connections.

12472. I understood they were prepared to meet you, but you must propose a scheme to them?—Some of them are prepared.

12473. I mean this is a simple thing; it is simply to propose that the inflow should be perfectly regular? —Yes, we could do that; there is no difficulty in that.

12474. And there would be no difficulty in their either accepting it or refusing it?—Or refusing it, getting their own engineer to design the works for them.

12475. Arising out of that, what is your view as to the whole of the trade refuse being treated separately from your domestic sewage—on a separate system?—Well, at Bolton the cost would be prohibitive. As I say, we have an area of 16,000 acres, the borough being practically seven miles by about four and a-half. The cost of separate sewers would be prohibitive—absolutely prohibitive.

12476. (*Colonel Harding.*) Suppose you had the separate sewers, and you were called upon to treat effluents separately from domestic sewage, do you anticipate that that would be an easier process to be carried out than it is of the mixture?—(*Mr. Ashton.*) No.

12477. You think it would be easier to deal with the mixtures?—Yes, certainly.

12478. So that there is no necessity to go to the expense of having trade sewers?—No, sir.

12479. (*Chairman.*) Then do I gather that the relative position and rights of manufacturers and local authorities are not, in your opinion, clearly defined under the existing law?—(*Mr. E. Ll. Morgan.*) They are not clearly defined, I think, sir.

12480. You would like to see the law altered?—The law altered and the authorities armed with powers which would enable them to detect such offences on the part of the manufacturers, and the provision of sufficiently deterrent penalties consequent on conviction for those offences. This is really a legal question. The town clerk went into this reply with me. It is purely a legal question, I think.

12481. Your manufacturers are not generally willing for the reasons that you have stated?—They are not generally willing.

12482. Now, in case of dispute between the local authorities and the manufacturers, do you think those disputes are best settled by an ordinary court of law, or do you think there would be any advantage in some central tribunal, such as a Central Government Rivers Board?—I think this sewage question is getting such a serious question, and getting so general, that it would be to the advantage of local authorities and manufacturers that some central board were appointed or formed.

12483. Did you happen to have seen a recommendation made in our Interim Report on that point?—No, I have not. I had a copy of the queries, and in answer to this one I say: I am of opinion that if such a body as suggested were appointed, viz., a Central Government Rivers Board, the members of whom would be practical men, this would greatly facilitate matters generally. I do not think the authority should be embroiled in any contention as to the method of treatment. The only question as between the authority and manufacturers should be: Is the effluent entitled by law to admission to the sewers, or is it one of the excepted matters? If the latter, the authority should be able to stop the connection, however praiseworthy the efforts of the manufacturers to render it unobjectionable may have been, and I think if there was a central board appointed it would relieve the authorities and manufacturers very considerably.

12484. (*Colonel Harding.*) That would be an ultimate court of appeal?—Quite so, sir.

12485. But I should be rather interested to know whether you think that your local rivers board, that is the Mersey and Irwell, is it not ——?—The Mersey and Irwell, sir, yes.

12486. Would have the confidence of local authorities on the one hand and manufacturers on the other if a first appeal were allowed to them?—Oh yes, undoubtedly. I think they have confidence in the Mersey and Irwell Rivers Board. There is no question about that at all, I think.

12487. May I ask you exactly what you mean by this statement: "I do not think the authority should be embroiled in any contention as to the method of treatment"?—What I suggest is that manufacturers throw the onus of suggesting a method of treatment on the local authority.

12488. That is to say, that they should direct their attention to the result, and not to the way in which that result is obtained?—Quite so, that the local auhority should direct their attention to the result of the treatment, without suggesting the method.

12489. And provided that certain features of the trade refuse were gained, they were not to consider how they were gained?—No, sir.

12490. Do you think manufacturers should be required to pay a special rate or charge in cases where they are allowed to connect with the sewers?—No, sir; provided they treat at their own works I do not see why they should, because really manufacturers are the backbone of every industrial town.

12491. They are large contributors to the rates?—They are large contributors to the rates. Provided they do their best at their own works I do not see that they should be called upon to pay an extra rate; but where they do not preliminarily treat, then a special rate should be levied.

12492. You have already put before us the difficulty of extra cost of treatment?—Yes, I think Mr. Ashton can give particulars of the extra cost of treating the trade refuse or mixed with our sewage at the present time. (*Mr. Ashton.*) That would be rather difficult to get at.

12493. You can only state in general terms that it does increase your difficulties?—Yes, in our particular case, taking the oxygen absorbed figure of the Mersey and Irwell Board, it does increase our difficulty of treatment about 30 per cent.

12494. About 30 per cent.?—Yes.

12495. And then, of course, that means a corresponding extra cost?—Certainly. (*Mr. Ll. Morgan.*) Pro-

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bably Mr. Ashton could give you some particulars as to the difference in the character of the sewage at holiday times and the working days. (*Mr. Ashton.*) It is more striking in the samples before you than any analysis.

12496. (*Chairman.*) Which trade refuse—are you speaking of any one in particular? You probably have one or two particular manufacturers in your mind?—The tanners are the worst offenders. In that case they send the most difficult matter into the sewers.

12497. And what are the contrasts that you were going to bring before us in their discharge—something about the holidays?—(*Mr. Ll. Morgan.*) Those are the three samples. (*Mr. Ashton.*) As I say, they are more striking than any analysis. Those are simply samples taken when there is no refuse being sent into the sewers, and a sample when refuse is being sent in, and a sample of this particular refuse. (*Mr. Ll. Morgan.*) The darker is the crude tan refuse, the medium is the sample of the sewage when they are turning in, and the best sample you have there is the sewage at holiday times.

12498. That is the normal domestic sewage when the works are at rest?—When the works are at rest; that happened to be at the end of last week.

12499. (*Mr. Power.*) Taken at the same time of day, are they?—(*Mr. Ashton.*) Yes, sir, they would correspond, at the same time of day.

12500. (*Chairman.*) May I ask you what would be the effect of the flow of water in the stream in these cases in which the manufacturer uses the water of the stream in his manufactory, if the trade refuse were delivered into the public sewers?—The effect would be this, sir, that it is as likely as not that it would embroil the Corporation in a law-suit.

12501. Because a great deal of your sewage goes on to the land?—(*Mr. Ll. Morgan.*) Goes on to the land.

12502. And is not returned into the stream directly?—Not into the same stream, as water abstracted from a stream put through the process of manufacture, and then put into the sewers, might result in the Corporation being embroiled in legal proceedings for diverting that water.

12503. Your outfall is discharged into the streams other than those from which the water is drawn?—Yes.

12504. Are there any other points which you would like to bring before the Commission?—I have none. (*Mr. Ashton.*) The only particular point is the suggestion of the equalising tank; that is the only particular point. I find that the trade refuse can be treated (provided a certain amount of solids are retained on the works) by using equalising tanks. I have a suggestion of this in my report.

12505. Would you like to put that in?—Yes, it is as follows:—"It is very difficult to secure a constant, neutral effluent with the Bolton sewage, owing to the quantity and variety of trade effluents which are poured into the sewers. Before we can calculate to introduce a standard chemical or chemicals to the sewage as a precipitant we must have a uniform sewage, and no doubt this will be very difficult to obtain. It can, however, be obtained in two ways, viz., (1) By adopting a large tank of twelve (12) hours capacity to be termed an equalising tank, through which the whole of the sewage would flow before receiving its dose of chemicals. The action of this tank on the sewage would both be destructive and putrefactive, both of which would play a very important part in the purification, or at least preparation for purification. I have had a small tank of this description working for nine months, the oxidisable matter being reduced 30 per cent., and the effluent from same during the past three months has been practically uniform in character; we could in this case effect a considerable saving in the quantity and cost of chemicals. (2) The second way would be far more difficult to accomplish, viz., enforcing a bye-law whereby all manufacturers would be compelled to distribute their trade waste, liquor, or manufacturing refuse, over a given period, into the sewers thereby causing a uniformity of distribution; and, moreover, all trade waste liquor should be preliminarily settled in tanks on the premises, and should only contain a fixed amount of solids before being admitted to the sewers."

Mr. Richard Johnson, called; and Examined.

Mr. R. Johnson.

12506. You are Chairman of the Sewage Committee of Bradford?—Yes, sir.

12507. I think we are favoured with the presence of the Mayor, too?—Yes.

12508. May I, in the first instance, ask you whether you admit manufacturing refuse into your sewers?—Yes.

12509. What is the volume of refuse compared to the total volume of your sewage, roughly speaking?—The volume of liquid refuse in comparison with the whole is about one-half.

12510. About half is trade refuse?—Yes.

12511. Is that discharged into your sewers regularly or intermittently?—Irregularly—intermittently.

12512. You find considerable difficulty, I believe, in the treatment of your trade refuse?—Some portions are difficult and some portions are not difficult.

12513. What do you consider your greatest difficulty—the intermittence of the flow or the character of the refuse?—The character of the refuse.

12514. The intermittence does not effect you so strikingly?—Yes, it does, in cases; we get sometimes a very strong sewage down, at certain hours.

12515. I may put it in this way, that it would be very desirable, and if you could you would insist, that the refuse should be discharged into your sewers at a fairly uniform rate?—It would be a great advantage to us if that were so.

12516. Why is it not so?—There are difficulties; manufacturers cannot always discharge it in that way; they have no storage capacity.

12517. That is to say, they are not in a position, from their circumstances, to have storage tanks in which they could keep their refuse before they discharge it into the sewage?—That is so; they cannot store it.

12518. They have no land on which they could erect storage tanks?—It is not always a question of having land on which to erect storage tanks; they have not the land on which they might treat it first.

12519. Yes, but with regard to simple intermission, that would be obviated simply by storage tanks; the quality of their refuse is such that it could not be stored?—It could not be stored in all cases.

12520. What are the features in the refuse that create so much difficulty?—Well, the chief difficulty is from the wool washing establishments. That, of course, is only 3-24ths of the total flow, but it is the most difficult to deal with.

12521. What proportion is it to the trade refuse? The trade refuse is 12-24ths; from the wool washing establishments it is 3-24ths.

12522. Three out of the twelve?—One-eighth of the whole, and that is very difficult to deal with.

12523. It is that portion which presents by far the greatest difficulty in the treatment of the trade refuse?—Yes.

12524. If that were eliminated may I say that you would have relatively little difficulty in treating the rest of the refuse?—It would reduce the difficulty, but it would not do away with the difficulty entirely.

12525. Very well, then, to return to the wool works, on what features does the difficulty depend there?—The presence of grease. That is a very difficult matter to deal with, and those people who do deal with it only take out about three-fourths of the grease contained in the liquid, which they then turn into the drains, the one-fourth of the grease. That which is left is the worst portion, and the peculiar acid which they use still renders it a very difficult effluent to deal with.

12526. You have an old difficulty, one-fourth is the grease, and that you say is the worst part of the grease, and then the addition of the acid?—Yes, which they put in.

12527. (*Sir William Ramsay.*) Is it sulphuric acid?—In some cases it is sulphuric acid, and in some cases they use ferric sulphate, but generally it is sulphuric acid.

12528. (*Chairman.*) Is it the large amount of acid which is discharged from these wool works in their

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process of extracting grease which you find to be a great difficulty?—Yes.

12529. You are unable to bring about a better purification of their refuse before it reaches you?—I do not think that we can quite compel the manufacturers to discharge an effluent which would be satisfactory to us owing to the many difficulties which present themselves. All manufacturers have not room, and most manufacturers who have room and put down some kind of plant, do it in a careless way, or only because they can make profit out of it, not for the purpose of treating the sewage, but for the purpose of recovering grease and to make a profit, and when the price of grease falls so low that it does not pay them, then they neglect the plant.

12530. Does that often occur?—That is frequently the case. The people who have charge of the grease extracting plant are generally inexperienced men, whose object perhaps would be to carelessly do the work, hence we get the sud in a more or less crude state. The manufacturer does not put down the plant for the purpose of treating the sud to turn out a good effluent, but for the purpose of recovering something which he can sell.

12531. Have you any suggestions to make as to what, in your opinion, should be done?—There is very great difficulty in making suggestions, and still greater difficulty in trying to carry them out. The only suggestion which I could make would be that manufacturers should pay to the Corporation an extra rate for the treatment of trade refuse, which should be governed by the volume they send down and by the nature of the effluent. That is, a special rate for sending down liquid refuse.

12532. And do you think it would be possible to make any statement as to what such a rate should be? Of course, you could easily admit a volume, but could you get a quantitative statement of the corresponding nature of the refuse?—I think so, if joint samples were taken, and one handed over to the manufacturer or to the wool washer, who would have an opportunity of sending that to some analyst to be tested, the same as ours would be.

12533. Yes, but your proposal is that according to your difficulty of treating this refuse he should pay an extra rate, but can you quantitatively estimate your difficulty?—I think so. I think there would be no difficulty in estimating; in fact, we know in a great many cases how much water he buys from us; the difficulty would be with those firms who pump their own water, who have wells.

12534. That refers to volume, does it not?—Yes.

12535. I said I imagined there would be no difficulty as to volume, but with regard to the quality?—I think there would be no difficulty about that. A chemist would tell us how many grains of impurity per gallon there would be in a sample if we took an average.

12536. It is not simply the quantity it is the quality, is it not, which also interferes with the purification of the sewage, and how are you to have a rate for quality?—They could tell the number of grains per gallon of grease or other impurities, and we could take an average. Sometimes the woolcombers would be washing wool which contains very little grease and very little mineral matter; at other times they would be washing a wool which is very heavy with grease; it would be necessary to strike an average.

12537. Just before we go on, may I ask what is the present system that you adopt with regard to your sewage—I mean in broad lines?—Well, we have tried many precipitants; we have tried ferric sulphate, we have tried a dry ferric sulphate partly mixed with sulphuric acid; at the present time we are carrying out a very lengthy experiment with sulphuric acid. We are finding, so far as results can go, that we are getting a very good effluent from sulphuric acid, that is, a tank effluent.

12538. (*Colonel Harding.*) Can you give us any figures in regard to the result that you have obtained by the treatment with sulphuric acid; what is the proportion of purification that you have obtained?—I could not give you any actual figures, but I think it is about 50 per cent. purification, but our engineer, Mr. Garfield, at a later date would be able to give you the actual figures.

12539. (*Major-General Carey.*) Is the sewage mixed with trade refuse?—The sewage is mixed with trade refuse. The whole of the sewage of the city of Bradford.

12540. Is mixed with trade refuse?—Well, with grease, piece washings, dye waters, yarn washings, and there is brewery waste and every kind of liquid trade refuse that is made within the city of Bradford.

12541. That forms occasionally not a small proportion of the sewage?—Well, from 4,000,000 to 6,000,000 gallons per day.

12542. The total output being about 10,000,000 gallons, is it not?—About that figure, perhaps 10,000,000 to 12,000,000.

12543. (*Chairman.*) That is to say, you are treating the grease yourselves?—We are not extracting the grease ourselves; a company to whom we have given permission is extracting the grease.

12544. But it is extracted, I mean, on the part of the local authority?—It is extracted by this firm for their own profit.

12545. (*Colonel Harding.*) And quite experimentally?—Yes.

12546. The plant has not been long at work?—From, I think, about the 1st March of this year.

12547. And what proportion of the total sludge you produce are they, with their plant, able to deal?—I could not tell you the exact proportion, but they have taken about 50 tons of liquid sludge per day, containing 85 per cent. to 90 per cent. of moisture.

12548. So that is a very small proportion of your production?—A tenth, perhaps one-eighth to one-tenth, the result of 1,000,000 gallons of sewage.

12549. That gives us the information I wanted—about one-tenth of your total?—About one-tenth or one-twelfth of the total. They have taken more than 50 tons some days, and rather less other days, but they have taken an average of 50 tons of liquid sludge per day.

12550. Then what you are doing is to treat by sulphuric acid your mixture of domestic sewage and trade effluents, and to settle certain matters which contain a large amount of grease?—Yes, grease not only from the wool combing, but the ordinary domestic grease.

12551. Then this greasy sludge you are experimentally treating, or it has been treated for you by a certain firm?—By a firm, yes.

12552. And you are unable, as yet, to give us any results, are you?—We shall have much better results in two or three months time—two months time; at least, we shall have more accurate figures.

12553. You cannot tell us anything as to financial results, but probably you can tell the Commission whether the grease is effectively extracted from the sludge?—The grease is effectively extracted, but I am not sure that it is extracted on a commercial basis; that is to say, that it is extracted at a profit on the working, but it is extracted.

12554. Assuming it cannot be done by that particular process, have you reason to think that by some other process it might be done?—We have very good reason to think so, and it is our intention to continue those experiments for some considerable time.

12555. (*Chairman.*) An experiment of another process?—An experiment of recovering grease from the liquid sludge itself, apart from the treatment of sewage.

12556. The liquid sludge after treatment by your sulphuric acid method?—Not alone by the sulphuric acid method, but by other methods. We have carried these experiments with alumino ferric.

12557. (*Colonel Harding.*) I suppose the reason you have taken to sulphuric acid is because it is a cheaper process than those you had used hitherto?—That is so.

12558. (*Chairman.*) And also that it is supplied in part by the sewage itself?—There is part of it comes down from the different firms.

12559. After the removal of the sludge, your sewage is in a satisfactory condition, and can be treated satisfactorily?—Well, I should like it to be satisfactory to the Rivers Board.

12560. But it is not?—I am not able to say that the Rivers Board are quite satisfied with it.

12561. (*Colonel Harding.*) I do not think the Chairman meant to suggest that the result of precipitation

would be satisfactory, but that it was in a satisfactory condition for further treatment?—We think it is quite as good by sulphuric acid as by any other precipitant we have tried.

12562. May I put it in this way, that after sulphuric acid settlement the effluent would contain sufficient acidity to prejudice its treatment on bacteria beds?—Our experiments lead us to believe that.

12563. That it would prejudice the treatment on bacteria beds?—No, that it would not prejudice treatment on bacteria beds—our experiments have been carried on during the last few weeks—but I should not like to speak too much about those, because I would rather have a longer period to see how they do work.

12564. But do you say that in treatment by sulphuric acid you would get an effluent which then could be effectively treated either on land or on bacteria beds?—The effluent which we have produced quite recently does not require a second treatment before it goes on to the beds; it goes straight on to the beds, and it gives a very satisfactory result so far as we have been able to tell.

12565. (*Chairman.*) On to the bacteria beds or on to the land?—On to the bacteria beds, it is a coal filter.

12566. Is it neutral?—That is a question I could not answer; the engineer can answer it later on, but it has not been a sufficient length of time at work for me to give any accurate information.

12567. (*Colonel Harding.*) The engineer is present, can he answer it now: Whether the effluent from your sulphuric acid settlement is neutral or not?—I am not quite sure that he can, because it has not been carried on for any lengthened period, and what may be the first action——

(*Chairman.*) Ask the engineer.

12568. (*Colonel Harding.*) Can you answer that question?—(*Mr. Garfield.*) It is decidedly acid.

12569. Is that to such an extent as to prejudice treatment on bacteria beds?—It is acid to the extent that one would expect it to seriously prejudice the treatment, but it does not. It is a most remarkable result that we are getting just now.

12570. (*Sir William Ramsay.*) How long has this treatment been going on?—It has been going on since April.

12571. Do you think the bacteria beds are in their full action by this time?—The beds had been in work for some twelve months before.

12572. (*Major-General Carey.*) Are you able to eliminate the greater portion of the grease before it goes on to the beds by the sulphuric acid treatment?—We are able to eliminate a great deal of the grease.

12573. You do not anticipate that the grease that remains will affect the beds?—I am not in a position to say that, Sir.

12574. (*Chairman.*) Then, I gather that you are not able, on several points, to give a definite answer at present, you are waiting further developments of your special experiments?—That is so.

12575. Have you considered whether it would be desirable to treat the trade refuse by itself alone, separate from the rest of your sewage?—(*Mr. Johnson.*) I have given considerable time to that, and my opinion —of course, I can only speak my own opinion—is that it is inadvisable to attempt to treat the trade refuse alone, unless it is of so small a quantity that it might be treated by evaporation.

12576. That is to say that, in your opinion, it is undesirable to apply a separate method to the trade refuse of any kind?—I think so; I think it is the duty of the municipality to accept it under conditions.

12577. Yes, but the point is, treating the trade refuse by itself with this or that method, and treating the trade refuse after it is mixed with the sewage?—I think it is better to treat the whole of the sewage mixed.

12578. Then are you satisfied with the present condition of the law as to the relations of manufacturers and local authorities in the disposal of trade refuse?—It would be very difficult for me to say how the law should be altered, and still more difficult for anyone to say how it should be put into force.

12579. But are you satisfied with it as it is at present?—Well, if the municipality had power to lay a special rate on manufacturers who put in the polluting liquid, I think that would cover everything that we require.

12580. That you think is the essential thing that is wanoted, this special rate?—I think that is the only solution of the question. I think you cannot make each manufacturer treat his own. You would be setting up a large number of very small nuisances all over the city, and they would be very unsatisfactory in the working.

12581. Your point of view is that instead of making each manufacturer bring his refuse in such a condition that it may be discharged into the sewer without creating difficulty, the local authority should undertake for all the manufacturers such preliminary purification, and charge the manufacturer for that?—Yes, after the manufacturer has put down, say, a certain settling process which does not require very much labour.

12582. (*Sir William Ramsay.*) But could you include all manufacturers. It practically amount to this, does it not, that it is those who discharge grease who give the trouble, and that all the manufacturers practically in Bradford do discharge grease?

12583. (*Chairman.*) Mr. Johnson told us a little while ago that this rate would be partly for volume and partly for quality?—Certainly.

12584. So that the manufacturer who had even a very large volume of relatively inocuous trade refuse would be charged, relatively, I suppose, little or nothing at all?—That is so.

12585. But the manufacturer who had even a very limited quantity of very noxious refuse would have a rate corresponding as far as could be judged to the noxious character of his refuse?—Charge his rate according to the quality of his effluent as well as according to the quantity.

12586. And that you think is a solution of the question?—That is my opinion.

12587. In cases of dispute which may arise between the local authority and the manufacturer, are you of opinion that those disputes are best settled by ordinary courts of law, or do you think there is anything to be said in favour of some central tribunal, which should be a court of appeal, and give final judgment?—I do not want to multiply the courts of appeal, or the number of authorities to which it can be taken step by step, and fight a long battle over; I am not sure that that would be of any advantage; but I think it would be of very great advantage if there was a court empowered by Parliament to decide not only whether manufacturers should come into the sewer, but also to decide when a local authority makes application for land. Parliament does not always decide that wisely, but a court which travelled and viewed the land, went from county to county, and in some central place held an enquiry, I think ought to be final, more especially when a local authority requires certain areas of land to treat the sewage.

12588. Then, I gather, you are in favour of such a central board, which, in the first instance, should deal with cases arising from difficulties between the local authorities and the manufacturers, and further that that board should have powers with regard to land required by local authorities and so on?—I think the latter is most important.

12589. You think there is a necessity for an appeal to a tribunal in such relatively simple process as that?—Yes, I think so. In Bradford we make an application to the Local Government Board, and after a very careful hearing and inspection on the spot the application of Bradford was granted, but when we came to have that sanction confirmed by Parliament, on account of the opposition of the owners we were defeated. Two years afterwards, when we came again to Parliament the House of Commons cut down the quantity of land which the Local Government Board had sanctioned, and then the House of Lords threw it out. I think that if a travelling committee or a committee perhaps in large counties or large centres were given greater powers over those things it would be an advantage to municipalities.

12590. (*Colonel Harding.*) Yours is a great and growing borough?—Yes, it grows.

12591. Therefore, I take it that new manufactories are put down from time to time?—New manufacturers have all to sign an agreement.

12592. Then, in the case of those new manufacturers applying for connection with your sewers you have no difficulty; you can make your conditions?—We have difficulty even when they have signed the agreement;

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the difficulty is to get them to keep the plant in working order.

12593. Then, in the first instance, you have no difficulty; you can get them to agree to certain conditions?—We have got some of them; we have not got all of them.

12594. But you are in a position legally to make your conditions, are you not?—Yes.

12595. Your difficulty is in getting the works kept up to a certain standard?—That is so.

12596. Then your real difficulty arises from those who claim a prescriptive right from long conection with your sewers?—That is one of the dfficulties. There are a good many firms in the wool washing trade who claim a prescriptive right, and that right Parliament has upheld and called upon us to pay a certain amount of money before they forfeit that right.

12597. You have to compensate them?—We have to compensate them so much per "comb."

12598. And the nature of the compensation has been settled by your Act of 1897?—By Act of Parliament, yes.

12599. I was interested to gather from your evidence in answer to the Chairman that you think it is really practicable for the local authority of Bradford to deal wholesale with these trade effluents mixed with the sewage; you think that the thing is practicable?—Oh, I think so, and I think it is an advantage to the health of the town that some trade effluents, such as dyers' trade effluents, which is 9-24ths of the total, should be admitted into the town sewers. In cases of very dry weather there is always a continuous flow of an acid effluent which would clear out any decomposing matter in the domestic sewer, and I think that tends to make the health of the city better. I think our death rate proves that.

12600. Then your view is that it is advisable, speaking generally, for the local authority to facilitate the reception of trade effluents into the sewers, subject, in some cases, to conditions?—Yes, if there is an effluent which is very bad the local authority should have power to call upon the pollutor to give some treatment to it first, but taking it as a general rule, I think it is an advantage to treat the whole of the mixed sewage, and I think it is the duty of the municipality to admit trade effluents.

12601. And you do not foresee that if it were possible to have in Bradford separate trade sewers, the treatment of trade effluents would be more easy by themselves than mixed with the sewage?—I do not think so; I think it would be almost impossible for a place like Bradford to have separate sewers.

12602. The cost would be too great?—Bradford is a very large area, and you see from the marks on that map (*exhibiting map*) that the different manufactories are situated all in different parts of the city, three to four miles away from the centre.

12603. But even if it could be done, you think there would be no advantage in doing it, because you can equally well treat the mixture as the trade effluents by themselves?—That is my opinion; I do not think that the wool-combers' effluent alone could be treated by itself, excepting by a process of evaporation; it would have to be mixed with the other kind of sewage to treat it by any other method except by evaporation.

12604. Are you able to tell the Commission how soon you will be able to deal with the whole of your normal flow by this sulphuric acid treatment that you have told us about?—We had hoped to have been in that position four or five months ago, but delays over which the Bradford Corporation has had no control, that is the manufacture of certain pipes, has delayed it until about the present time. We hope very shortly to be in a position to give a 50 per cent. treatment to the whole of the sewage of Bradford.

12605. Within what period—within a month?—Oh, less than a month; we are only waiting for the pipes; everything else is ready, and they were sent off last Thursday.

12606. Have you plant by which you will be able to deal with your sludge experimentally before?—We have four methods of dealing with our sludge, or rather three methods. We have one method which takes 50 tons a day for the purpose of extracting grease; we have another method which will press perhaps 100 tons a day, and that pressed cake will have to be removed on to the land, and then we have two large places where we intend to put the liquid sludge untreated.

12607. But you will be able, will you, to produce this sludge and deal with it by one or other method?—We shall dispose of it in those three ways.

12608. So that your plant will be able to deal with the whole of the normal flow of Bradford?—Yes.

12609. To the extent of the first purification?—To the extent of the first purification.

12610. (*Chairman.*) We shall all be interested now to learn from Mr. Garfield what was the effect of the treatment on the condition of the sewage?—Mr. Garfield in a few weeks time will be able to put before you many very interesting matters, especially with regard to the extraction of the grease, which I venture to say is one of the most important that has been undertaken by any municipality yet in England.

12611. (*Colonel Harding.*) The question that was put to Mr. Garfield was as to the effect and the condition of the effluent from sulphuric acid settlement; whether that effluent was not too acid to be dealt with on bacteria beds; is he able to answer us that now?—(*Mr. Garfield.*) I could answer it provisionally. The effluent from the sulphuric acid precipitation is exceedingly acid.

12612. (*Chairman.*) What amount of acidity, what are the limits within which it has varied?—It has gone up from three grains per gallon to more than 18. I am not quite sure of the last figure, but it was more than 18 grains per gallon of sulphuric acid. I have been applying that to a filter bed, to a bacteria bed, and to my surprise with very fair results.

12613. What kind of bacteria bed is it—is it a continuous filter?—It is an intermittent sprinkling, not a contact bed, an open bacteria bed.

12614. (*Sir William Ramsay.*) Whitaker?—Well, it is simply an ordinary sprinkler, not Whitaker—fine material.

12615. (*Chairman.*) And what has the result been so far?—The result has been quite different to what I expected, the acidity of the effluent does not appear to have interfered in the way one would have expcted with the final effluent. I am now sending samples for the purpose of bacteriological examination to the bacteriologists of the Royal Commission.

12616. How long has this experiment been going on?—The filter has been receiving the acid effluent since April.

12617. And what is the chemical result—do you pass it through more than one bed?—Through only one bed, sir.

12618. What is the character of the effluent from that bed?—The oxygen absorbed is reduced very much indeed. I can give you rough figures, I have not exact figures: Oxygen absorbed in the crude sewage was about 15 grains per gallon; in the tank effluent it was reduced to about 6 grains per gallon; the final filter effluent reduced it to a little more than 1 grain per gallon. The albuminoid ammonia was reduced in not quite so large a proportion.

12619. (*Colonel Harding.*) Do you remember the solids in suspension from your tank effluent?—The last time it was 6 grains per gallon. That was dealing with a flow of 3,000,000 gallons per day.

12620. (*Chairman.*) Could you determine the nitrates in your effluent?—No, sir; unfortunately the chemist has omitted the nitrates. In April they became very low indeed. I am now having a special investigation made into the question of nitrates and nitrites.

12621. They began low when you began to use this acid liquid, do you mean? The nitrates were low in April?—The nitrates were low when we began, after we had used sulphuric acid a short time.

12622. You determined the nitrates then, and you found them very low indeed in the effluent from the bacteria bed?—That is so.

12623. (*Mr. Power.*) Compared with what they were before you began to use this material?—Yes.

12624. (*Chairman.*) These are old beds which had been used for some time before?—They were.

12625. They were matured beds?—They were matured beds.

12626. If they were not, you would not expect nitrates at first—not for some weeks?—No.

12627. (*Major-General Carey.*) Is the sewage treated

in open septic tanks before it is discharged on to the beds?—No, it is treated in ordinary tanks—open precipitation tanks.

12628. (*Sir William Ramsay.*) With what?—With sulphuric acid, and the effluent has to go through a pump on to the bacteria beds, but the time from the tank to the bacteria bed is very short indeed.

12629. You give it some sort of filtration before putting it on the beds?—None whatever.

12630. But is the object not to recover grease; is the object of adding sulphuric acid not to crack grease, as it is called?—The object of the sulphuric acid is to precipitate the sewage, to get a partial purification, 50 per cent. or 60 per cent.

12631. But does not that purification consist largely of separating the grease?—The object is to get the grease into sludge.

12632. (*Chairman.*) Have you any bacteriological results at all; have there been any bacteriological examinations of your bacteria beds during this acid treatment?—I have sent about 12 samples, I think, to your bacteriologist, Dr. Houston.

12633. (*Mr. Power.*) And before you commenced it, under the old conditions, have you bacteriological analyses of the results?—No, we have not.

12634. You can give us the comparative chemical results before and after, but not the bacteriological?—Not the bacteriological, no.

12635. (*Major-General Carey.*) If this experiment were successful, would the Corporation be prepared to carry it out for the whole of the sewage in the borough?—Sulphuric acid precipitation.

12636. And bacterial treatment?—Well, we have not sufficient room to carry it out; it is a very slow process, bacterial treatment.

12637. You mean at Frizinghall?—At Frizinghall.

12638. Have they any intention of going beyond Frizinghall just now?—We have not asked to go beyond Frizinghall at the present time.

12639. I thought there was some land that belonged to you on the other side?—It is a small quantity of land and very low lying; it is not land upon which we could commence to construct works. (*The Mayor of Bradford.*) The Lords threw out the Bill.

12640. I thought you had acquired a considerable quantity of land adjoining that other?—(*Mr. Garfield.*) It is land which would be useful, but not land upon which we could commence to carry out a permanent scheme; it is part of the lowest land in the valley.

12641. (*Colonel Harding.*) In the event of your finding, Mr. Garfield, that the acidity did prejudice the further treatment, would it be a very serious expense for you to neutralise the effluent before it passed on to the beds?—I anticipate some difficulty in that from passing effluents treated by sulphuric acid on to land, but I am not able to give you any figures.

12642. (*Chairman.*) Where would the difficulty be?—In getting a second precipitation.

12643. Do you need the second precipitation—I mean, you only want to neutralise it, or at all events, to reduce the acidity?—In neutralising it we should get a second precipitation in the operation of neutralising it.

12644. (*Colonel Harding.*) It is chemically quite practicable; it is a mere question of finance, is it not?—Well, there are certain mechanical difficulties in getting precipitation of the particles in suspension. I anticipate there will be very great difficulty in precipitation; I am not able to speak with any decided authority on that point.

12645. (*Chairman.*) I gather that there are a good many things held in solution by the sulphuric acid which would be precipitated on neutralisation?—Yes, if the effluent is neutralised by lime, for example, it becomes opaque and very muddy.

12646. I do not know, Mr. Mayor, if you have any views that you would like to put before us as to the system now being carried on at Bradford?—(*Mayor of Bradford.*) None, except those expressed by Mr. Johnson. I quite agree with the views he has expressed. I think we may fairly ask manufacturers to join together, and perhaps compel them to make a separate sewage system for their trade refuse, but I am afraid if we did so we should drive them away to other localities, and that we cannot afford.

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12647. As far as I understand Mr. Johnson's position, it is this, that he thinks that the trade refuse, as a whole, may be better treated when mixed with the sewage than when treated separately, and that it might be done best, naturally under those circumstances, by the Corporation, who would charge the manufacturers according to the amount of trouble they have caused, in proportion?—(*Mr. Johnson.*) That is so, but there may be certain exceptions.

12648. In certain cases you think that some preliminary treatment might be carried on at the individual works before it is discharged into the sewers?—Yes, and that would have the effect of lowering the charge that has been made against them. (*Mayor of Bradford.*) There is a firm at Bradford who do so separate the treatment, and some of them do with considerable profit to themselves.

12649. I mean really you wish to charge against the manufacturer only the cost to which you yourselves have been driven in treating the sewage owing to the mixture with his refuse?—(*Mr. Johnson.*) A part of the additional cost. Of course, if the manufacturer put down a plant, and took out a large quantity of the impurities, he would pay a very much smaller special rate, but if he allowed it to go in a crude state, he would be charged a very much higher rate, and it may perhaps pay him to reduce his impurities, because we might by that means get at the man who does nothing at all.

12650. You would leave it freely open to the man himself to find which was to his advantage?—Certainly, many of them are not able to do anything at all; those people ought to be put on a different footing to those who do all that they can.

12651. That is only dependent, is it not, upon the view that the trade refuse can be, as you think, better treated after mixture with the sewage than by itself?—Well, I should say that in 99 cases out of a 100 it can be treated mixed; there may be an isolated case here and there, even the wool washers' effluent.

12652. That is assisted by the fact that in many cases the different forms of refuse, so to speak, neutralise each other?—Yes. (*Mayor of Bradford.*) I should like to accentuate what has been stated in support of the appointment of a travelling committee, with powers to judge for themselves on the locality, and the necessities of the locality. Bradford's treatment in the House of Lords and the House of Commons respectively has been extremely cruel and extremely expensive. I think that would have been obviated if we could have put our case *in situ* before a responsible committee.

12652*. (*Colonel Harding.*) Just one question, Mr. Mayor, in order to enable the Commission to appreciate the gravity of the problem that you have to deal with at Bradford, both with regard to yourselves and to those who are lower down the stream. I suppose all the effluents from various works pass ultimately into the Aire, do they not?—That is so. There is some slight exception, in our newly acquired districts, in the neighbourhood of Tong; if you remember, I think some of those got into the North Bierley, the Spen Valley—Spen Beck, which is equally offensive.

12653. Mainly they flow into the Aire?—Yes.

12654. And the condition of the Aire above the confluence of the Bradford Beck with the Aire is relatively good?—Relatively good.

12655. And below that confluence, especially after the Aire has travelled several miles, the condition of things is exceedingly bad?—We freely admit that.

12656. And the urgency of something being done is acknowledged on all hands?—Absolutely.

12657. You tell the Commission that you are able to see your way to treating by sulphuric acid the whole of your sewage in such a way as to produce a first process purification of about 50 per cent., and that within a very short time?—That is so. (*Mr. Johnson.*) Either by sulphuric acid or by some other process; by a process we propose to extract 50 per cent. of the impurities.

12658. The Commission will be greatly interested to hear Mr. Garfield at a later date, whether he finds that effluent after your sulphuric acid process is capable of treatment on land or in bacterial beds, that very important part in the future of your scheme?—That is a matter we are watching very carefully, and have done during the greater part of this year. We have taken a great deal of information, and Mr. Garfield will be able to lay it before you at another time.

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Mr. E. A. BROTHERTON, M.P., called in; and Examined.

12659. (*Chairman.*) You are the chairman and managing director of Messrs. Brotherton and Co., Limited, and I think you are willing to give us some evidence relative to the quantity, character, and mode of treatment of the effluent discharged from your works into the public sewer?—Yes.

12660. You have sent in a statement, which we may take as read?—Yes, sir.

Leeds.

The quantity of ammoniacal liquor produced at the several gas works of the Leeds Corporation amounts to about 9,000,000 gallons per annum. The whole of this quantity is delivered to the works of my firm, which are adjacent to one of the gas works, and where it is treated to recover the ammonia which it contains to the extent of about 2 per cent.

The rate of treatment averages about 50,000 gallons per day of 24 hours for 180 days per annum, during which the plant is at work. This quantity is increased to probably 57,000 gallons by the condensation of the steam used in the treatment, and this will represent the total quantity discharged into the Corporation sewers during each of the days referred to.

The liquor as it leaves the distilling plant contains a fair amount of lime in suspension, approximating to 400 grains per gallon, but this is settled out by causing the liquor to pass through a series of settling tanks, and so efficiently is this done, that the effluent as discharged into the sewer contains only ·01 per cent. of total solids in suspension, equal to 7 grains per gallon. The temperature also at the same time is brought down below that required by the Act (110°F.).

The settling apparatus consists of iron tanks, and also bricked pits, giving a total of about 3,600 square feet surface area, and a holding capacity of about 160 tons of water.

The character of the effluent may be judged from the following analysis:—

	Grms. per 100 c.c.
Water - - - - - - -	97·786
Calcium Thio-Sulphate ($Ca. S_2 O_3$) -	0·072
„ Sulphocyanide ($Ca. (C.N.S.)_2$)	0·250
„ Chloride ($Ca. Cl_2$) - - -	0·838
„ Ferrocyanide ($Ca._2 Fe C_6 N_6$) -	0·020
„ Sulphate ($Ca. S O_4$) - -	Trace
„ Oxide ($Ca. O$) - - -	0·137
Tarry matter and combined water -	0·897
	100·000

The sample was filtered before being analysed, to remove the solids in suspension. The sediment thus removed amounted to ·01 per cent. (7 grains per gallon), and consisted of carbonate of lime.

The colour of the effluent is of a somewhat dark amber, and shows an alkalinity calculated equal to 235 grains of caustic soda per gallon, mainly due, of course, to the lime used in the treatment of the liquor.

The dry weather sewage of Leeds is stated to be about 16,000,000 gallons per 24 hours. The effluent from the distillation works would therefore represent about ·35 per cent. of the total on the days when the process was at work.

Some few months ago the Corporation alleged that the effluent was precipitating the domestic sewage and blocking the comparatively small sewer into which it was being discharged, and we were required to construct a long drain so as to deliver it into the main sewer, where no such complaint could be made against it. This work was duly carried out at considerable cost to ourselves, and matters have since gone on satisfactorily.

Wakefield.

In the case of the ammonia works at Wakefield, the quantity of the effluent discharged would amount to about 29,000 gallons per day during each of the 147 days the plant is at work.

The dry weather flow of sewage at Wakefield is stated to be about 2,250,000 gallons per 24 hours, so that if the whole of the effluent from the gas liquor works was allowed to enter one sewers, it would represent 1·3 per cent. of the total. But this is by no means the case, because the settling out of the lime is performed in lagoons and channels constructed in a large open field, and in its course through these, the lime solids are deposited, and the liquor percolates the ground to such an extent, that practically none finds its way into the sewers.

The character of the clear liquid is very similar to that described under Leeds.

There is little difficulty in separating out the solids in the manner described, and, given sufficient space, I do not see any hardship in requiring manufacturers engaged in similar processes to remove the solids before discharging into the sewer.

12661. Perhaps I may proceed to ask you some very general questions as to your views, and in the first place, as to the admission of manufacturers' refuse into sewers. Have you any distinct views about that; I mean as to whether it should be admitted, or as to whether there should be any restrictions, or as to what regulations are desirable, because I imagine you speak from the point of view of the manufacturer, do you not?—No; I would hardly like to say that. What I would say is this: I would speak from as general a standpoint as possible, although I am a manufacturer.

12662. Really the point is, I think, is it desirable in the first instance that manufacturers' refuse should be admitted into the town sewage, or, where practicable, should be treated separately?—I do not think it is desirable for manufacturers to be able to compel the local authorities to admit their effluent, if it can be shown that the effluent is detrimental to the general community.

12663. It is a matter of degree, is it not, that sewage, whether manufacturers' refuse or not, can be treated in a certain definite way? Does the admission of refuse in a certain quantity or of a certain quality interfere with that treatment?—Yes.

12664. Well, we have had proposals on the one hand that the refuse should be treated in such a way that it would not interfere with the general treatment of the sewage before it is admitted into the sewer; on the other hand, an opinion has been expressed that it is best that the refuse should be admitted into the sewer and treated with the rest of the sewage, and that the manufacturer should be charged for the extra cost which is thrown upon the authorities in so treating their sewage?—Well, to answer the question in a general way, I am certainly of opinion that manufacturers ought to be under the obligation of treating the effluent themselves, and not to be able to throw the onus of it on the local authorities. I could imagine, in cases where the onus was thrown upon the local authorities, considerable complications would arise as to what the cost of treating the effluent would be. In my opinion, in a general way it might be said that manufacturers should not turn anything out into the sewers which is detrimental to the fair treatment of the sewage.

12665. And is it your opinion that it would be not unfair to insist that the several manufacturers should so manipulate their refuse as to bring it, before it is discharged into the sewers, into such a condition as would not materially interfere with the ordinary treatment of the sewage?—That is the principle I would strongly recommend. I would say this, as to any unfairness, that it would be unfair were the manufacturers compelled to treat it without giving them reasonable time, or compelled to do it without taking into account their exact position.

12666. The latter is of very great importance, is it not?—It is, sir.

12667. I mean it is comparatively easy for certain manufacturers under certain circumstances, with abundance of land, and so on—abundance of room; they can put up this or that installation without any great difficulty, and so act upon their refuse as to render it relatively innocuous. An old manufactory in the middle of a crowded city is placed under very different circumstances?—My works are under the Alkali Act of 1881, and when the Act came into force the best available means were to be taken. I think that was found to work very well. The Alkali Act is worked under a central authority. We have no local inspectors; we have district inspectors, but they are directed from Whitehall, and by having inspectors of that class, men who are able to appreciate the circumstances of each

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manufacturer, men who know what the best available means are, manufacturers, I think, under that Act have not been found to suffer; and something similar might be contemplated with regard to sewage.

12668. That is to say, you would advocate some such system being introduced with regard to trade refuse in sewage as obtains with regard to the Alkali Act?—Yes; I would certainly, both with regard to the best available means.

12669. And with regard to the authority for determining what are the best available means?—Yes.

12670. Did you look at our interim report, in which it is suggested that there should be a central tribunal?—I am sorry I have not seen that.

12671. A kind of Government Rivers Board; a central tribunal, to whom all these various disputes might be referred, who would have the necessary technical appliances, technical knowledge, and so on; men possessing technical knowledge, so as to be able to formulate a system. That, I imagine, is what you think coincides with your opinion?—Quite so; the creation of such a central authority would strongly recommend itself to me. It would be undesirable for manufacturers to be under local inspectors; when it came to cases of dispute, they would not have sufficient experience—the local inspectors—in many cases, and they might be subject to local influences, which would be very undesirable.

12672. On the other hand, knowledge of the local circumstances is essential in coming to a decision on these points, but that could easily be obtained by such a tribunal?—I quite think so.

12673. With regard to the cost of such treatment as was necessary, of course, where the manufacturer himself treats his refuse in such a way that it can be discharged into the sewer without detriment to the general treatment of the sewage, the question is solved; but where he is unable to do more than a preliminary treatment, and perhaps is not able even to do that, and where the discharge of his refuse does not entail a greater cost upon the local authority in their treatment of the general sewage, is it your opinion that the local authority would be justified, in that case, in insisting upon a special rate on the manufacturers?—I think the local authority would be quite justified in insisting upon the manufacturer bearing his fair burden of the extra cost entailed in treating his effluent.

12674. Then, speaking generally, I suppose we may say that it is your opinion that if there were such a central authority which, with adequate knowledge, could determine conflicting cases and with power of the local authority to insist upon a special payment in the case where they had to incur extra cost in order to treat the general sewage, that the refuse question might be settled?—Well, sir, there might be cases in which it would be impossible for the local authorities to admit the effluent from certain works; it would be so much to the detriment of the sewers that it would be impossible to admit them.

12675. You mean cases in which no treatment on the part of the manufacturers would bring their refuse in such a condition that it might safely be discharged into the sewer without detriment to the general sewage?—No; I do not conceive that, but I do conceive that there may be works where there is insufficient space for treating, and the effluent might be run into the sewers and do great damage. In such cases as those I would go so far as to prevent the manufacturer from proceeding with his trade.

12676. (*Colonel Harding.*) And that would really stop that particular trade?—If the manufacturer could not carry on his trade owing to his surrounding circumstances, I think his trade would have of necessity to stop.

(*Chairman.*) But that trade might be a very valuable trade, and valuable to the locality as well.

12677 (*Colonel Harding.*) Take the case of your own trade at Leeds; suppose, for instance, the Corporation of Leeds were to say and to maintain the position that they would not allow you to continue to turn your effluent into their sewers; what could you do; would you have to evaporate it only or give up the works, or what?—Well, that is assuming that I should not make it in such a condition as they could accept it.

(*Chairman.*) But is not that really a very exceptional case; I mean, is it not a theoretical case that the trade refuse cannot be so treated, that when admitted into the general sewage it can be treated with the rest of the sewage?—Most exceptional, I should say.

12678. And theoretical almost?—And theoretical almost.

12679. Theoretical, because what it means is this, that the manufacturer must adopt unusual methods, and must find out new methods for so treating his refuse, that it shall be delivered into the sewage under such conditions as will not interfere with the general treatment of the sewage?—I could not imagine any chemical manufacturer who would be unable to treat his effluent in such a manner, providing he had time and was not unduly pressed; providing he had time and reasonable facilities, I could not imagine any manufacturer who could not discharge the effluent in a manner that would be satisfactory to the local authorities.

12680. (*Major-General Carey.*) Take the case of Bradford, for instance, where they have to deal with a large amount of grease in the wool scouring, would it not be difficult, do you think, for an individual manufacturer to treat his trade refuse to such an extent that he would produce it free, or to a great extent free from grease, and then hand it over to the authority?—The manufacturer would have difficulties, but I do not think they would be insurmountable. If he knew he had to do it within a certain period, if he had the way indicated to him how to do it, I think you would find the manufacturer would fall into line.

12681. (*Chairman.*) It is extremely improbable, is it not, that the cost which would be thrown upon him of treating his refuse would be so great as to interfere with the profits of his trade?—It would be extremely improbable, with a proviso, that reasonable time were given to him to make such alterations or adopt such means as were essential.

12682. I do not know whether there are any other points that you would like to bring before us. For instance, I do not know what your experience is, what are the ordinary difficulties that the manufacturer meets with in dealing with local authorities?—Well, speaking for myself, I have not found that they have been at all unreasonable, when they have been met in a proper spirit.

12683. So far as the evidence has gone before us at the present time, there are two great difficulties which the local authorities meet with in regard to trade refuse; one, and perhaps the most prominent one, is the irregularity of the flow, that a manufacturer will be at one moment discharging very little into the sewer, and then he will discharge the whole of his refuse within a very limited time into the sewer. That is one difficulty. I suppose that can always be met, or can be met at all events in the vast majority of cases by storage tanks, which would permit the flow to be more or less continuous?—I should say, if the intermittent quantities are detrimental to sewage treatment, the manufacturer may reasonably be called upon to regulate his flow.

12684. As matter of fact it is very detrimental, the fact that you get a large quantity at one time, and when, for instance, you are treating the sewage in a definite way, which, on the supposition that the sewage has a certain average composition, a large manufacturer sends in a very large quantity of refuse totally alters the character of the sewage in a very short time?—Yes.

12685. And upsets the arrangements which were made for the ordinary sewage?—Yes.

12686. That is one difficulty; the other is the nature of the refuse, some refuse being more detrimental than others. Well, that has to be met on the one hand by special treatment by the manufacturers before the refuse is admitted into the town sewage?—I would recommend that the manufacturer be called upon duly to discharge the effluent in such a manner as it can be reasonably treated.

12687. I do not know whether the question of riparian rights has ever come before you with regard to removing water from a stream for manufacturing purposes, and the duty of discharging it back into the stream?—Yes, I have to discharge it back, and, I understand, that it is obligatory on me, and I do not object to it.

12688. It seems to me to be essential, or else the

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character of the streams would alter altogether?—I quite agree with that.

12689. (*Colonel Harding.*) You think then, that it is quite reasonable that manufacturers should be called upon to carry out certain conditions before the authority receives his effluent?—I do.

12690. And from your own experience, you think that, speaking generally, it is practicable for him to carry out those conditions without ruin to his business?—Yes, I would, as I say, make it a condition that the manufacturer is only called upon, any way for the first two years, to use the best practicable means.

12691. Yes, we do not want theoretical purity, we merely want him to carry out what is possible to be carried out, so as not to prejudice the treatment of the sewage.

(*Chairman.*) That is a most important point—that the manufacturers should be allowed time in order to make the necessary arrangements.

12692. (*Colonel Harding.*) The interest of your evidence seems to me to be this, that authorities, for the most part, have laid it down that one of the main things they are to ask the manufacturer to do is to settle solids. Now, in your case, you have been turning into the Leeds sewers an effluent which is fairly clear, but that effluent has been found to be very objectionable, because it caused a precipitation in the mixture in the sewer into which it flows, so that you see mere settlement of solids in this case was insufficient. The character of the clear effluent itself, was such, as to cause rapid sedimentation in the small sewer, and in your evidence, you tell us that you have been compelled by the local authority at Leeds to go to some expense, or to share the expense, of going to a larger sewer?—No, I think we bore the whole expense.

12693. At any rate you were put to considerable expense in carrying your effluent into a larger sewer?—Yes.

12694. Where on account of greater flow of domestic sewage these evil results did not arise?—Yes.

12695. It may be therefore necessary in some cases to call upon a manufacturer, not only to settle solids but to alter the chemical composition of a clear effluent, so as not to bring about inconvenient results in the sewer?—That is true, yes.

12696. I may take it, of course, that you have been able to carry out what has been asked of you by the Corporation of Leeds, without serious interference with the profits of your business?—Yes, the expense was putting down a new sewer, instead of using the small one which was available before.

12697. It is a great advantage for a manufacturer to have his effluent received into the sewer?—Decidedly.

12698. In your case it would put you to very grave inconvenience if it were not received into the sewer?—Very.

12699. It seems to you that local authorities ought to have the necessary powers to exact from the manufacturers reasonable conditions?—I think that is exactly the position.

12700. (*Major-General Carey.*) Whether a trade refuse is going to be admitted into the sewers from a new manufactory, or whether any trade refuse is already admitted into the sewers by prescription, that the local authority should have the power to say: "You must treat your trade refuse before we can continue to allow it to be taken into the sewers?"—I am quite of that opinion. Of course, with the proviso, I have already mentioned that they only exact what is practicable or considered practicable, not by their own officer alone, but by a central authority who would be capable to see the position from a more general standpoint.

12701. The other alternative would be for the authority to say to the manufacturer whose trade refuse was already admitted into the sewers: "We will continue to admit it, provided that you will pay some extra rate for our cost of treating your trade refuse?"—Certainly, if there can be an agreement between the manufacturers and the local authority, no reference would be required to the central authority. In the case of disagreement, the central authority would be there to have their services available. I would not say that a manufacturer should compel the local authorities to take the effluent, unless the effluent was of such a nature as they were willing to take.

FORTY-SECOND DAY.

Wednesday, 2nd July, 1902.

PRESENT.

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P. (*Chairman*).

Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Mr. W. H. POWER, F.R.S.
Colonel T. W. HARDING.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS (*Secretary*)

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Mr. DAVID HOWARD, called; and Examined.

12702. (*Chairman.*) You are a Fellow of the Institute of Chemistry, a Fellow of the Chemical Society, and Vice-President of the London Chamber of Commerce?—Yes, sir.

12703. And you are a chemical manufacturer?—Yes; my firm has been in existence for 105 years.

12704. Your manufacture has brought you into contact with this question of the disposal of your refuse?—Our own experience is limited to draining into the Lea, and, although the sanitary authorities have reduced the Lea into a condition which it is rather difficult to pollute, we, of course, have to take care that we do not add to the already terrible condition of it. That is our own experience. But in connection with the Institute of Chemistry and in other ways, I am constantly brought into contact with manufacturers, and I know both the experience of manufacturers in my own neighbourhood, and, to a certain extent, of those in other neighbourhoods.

12705. You are speaking rather of what you know from the experience of others?—Our experience, as I say, is confined to purification for river pollution, though the cases run on all fours.

12706. Is the effluent that you discharge into the Lea large in volume?—It is comparatively very small in volume.

12707. How much roughly?—Perhaps 2,000 or 3,000 gallons a day.

12708. And what are the chief constituents?—There is a certain amount of organic matter from citric acid and quinine, and so forth.

12709. Is the reaction prominently acid or alkaline?—They neutralise one another, and, after settling well it has been tested by the Commissioners, and they found nothing to object to in it.

12710. No large amount of solid matter in it?—No solid matter in it.

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12711. It is in solution?—Any solid matter is settled and dealt with in that way.

12712. Before it is discharged into the river?—Yes, sir.

12713. So that you discharge into the Lea a fairly clear, neutral fluid?—Yes.

12714. With a small quantity of organic matter in solution?—With a small quantity of organic matter in solution, yes.

12715. Then, your experience with the position of other manufacturers has led you to views as to whether the existing law is adequate with reference to the position and rights of manufacturers and local authorities respectively?—The question appears to be exceedingly obscure to the minds of most manufacturers. I might say in the neighbourhood of London the County Council and the local councils make as little difficulty as possible, except in cases where there is anything dangerous to the sewers, or noxious to the health of the men employed in them; and therefore I should say that in my own district, and in the neighbourhood of London, every facility is afforded that ought to be, but it appears to be exceedingly doubtful whether a manufacturer can claim it as of right; whether the enactment which allows, I think, that every occupier or owner of any premises within the district of a local authority shall be entitled to cause his drains to empty into the sewers of that authority, gives a general power to send anything into the drains, does seem uncertain, and, of course, it is a most serious matter when there is uncertainty for the manufacturer. If, on the one hand, he is merely existing on sufferance, his position is a most dangerous one, and, on the other hand, if he has no rights at all, it renders the position of a manufacturer almost impossible in England, except under very special circumstances.

12716. Then it is chiefly the uncertainty of the law rather than any definite regulations laid down by the law?—As far as we can discover, there are no definite regulations, except that nothing injurious to the sewers, or at any excessive rate, should be passed in.

12717. (*Colonel Harding.*) Is not that fairly clear?—That is perfectly clear.

12718. The manufacturer is entitled to ask to be allowed to connect with the sewer if the sewer is large enough, if the matter proposed to be sent down does not injure the sewer itself, or prejudice the treatment of the sewage?—That is my own belief, but it appears a great many manufacturers are in great doubt about that.

12719. But that is really what is stated, is it not?—Yes; but then he causes his drains to empty into the sewers. The question is really what the drain means, whether it means a drain in the wide sense, or merely a drain for house discharge. I should think it covered the ground; that is my own impression very strongly; but then, I am not a lawyer, and I never express a legal opinion.

12720. (*Chairman.*) Are you acquainted with Section 7, part 4, of the Rivers Pollution Act of 1876?—That is with regard to rivers pollution?

12721. Yes?—When the Act was before the House I paid rather special attention to it.

12722. It gives the manufacturer a right to connect with the sewers, subject to certain provisos?—Then that would entirely answer my question. Yes, that certainly does. It is clear—perfectly clear. I remember the Act as applying to the pollution of rivers; I studied it very carefully, but I did not study it on that point before. On those lines, it seems to me that manufacturers have nothing to complain of, because clearly they have no right to destroy sewers or poison the people that work in them.

12723. (*Colonel Harding.*) It must be largely a bargain in each special case between the manufacturer and the local authority, according to the merits of the case?—Exactly so.

12724. (*Chairman.*) Which bargain is successfully carried out in London and the neighbourhood?—Yes, and in the majority of cases. Of course, there are very difficult questions arising. A perfectly innocuous effluent may meet another equally innocuous effluent and fill the drain with plaster of Paris. If one factory is running chloride of calcium, which is very harmless in itself, into the sewer, and another sulphate of soda, equally harmless in itself, there have been cases where sewers have been actually solid.

12725. That is to say, whether the effluent is innocuous or not must be judged by the result after it has been discharged into the sewer?—Or by the consideration of such possible mixtures.

12726. I mean that it is not exactly the condition of the effluent as it leaves the works, but the effect which it produces upon the sewage?—That requires a knowledge of what is going on in the whole system of the sewage.

12727. Have you any suggestions to make as to the safeguards required to secure that the refuse should be delivered in such a way as not to interfere with the proper purification of the sewage? I mean there are generally two elements there; one is the uniformity of the discharge. There is a great deal of evidence that where the discharge is exceedingly intermittent it interferes very largely with the due purification of the sewage. That is one thing. The other thing is the sewage containing certain constituents?—What appears to me about that is that it is very important that it should be dealt with by those who have specially studied the matter. I think there is a power of appeal now given under the London County Council General Powers Act to the Local Government Board if there is any dispute. I do not know whether it has been found necessary to put it in force, but some such power certainly should be given. It is a very complicated question, and the sanitary advisers of the local authority may be very excellent men in their way, but it does not at all follow that they grasp all these complicated matters. The Local Government Board inspectors have immense experience, and the alkali inspectors have very special specific knowledge, and it seems to me that if it be possible the alkali inspectors should have a word about the effluents from factories and report upon them. I do not see why what escapes into the streams should not be looked after as much as what escapes into the air, and that there should be power of appeal similar to that under the London County Council Act.

12728. You are in favour, I gather, of there being some appeal, some tribunal, such as a central Government Rivers Board?—Whether it be to a Rivers Board or to some other authority, the more specialised the authority is the better, because the question requires special knowledge; but it should be a cheap appeal, because there is always a great danger of local authorities running up costs. It is not their own money that they are fighting with, and their legal advisers want to make it safe, and so litigation becomes extremely expensive unless care is taken to obviate this danger.

12729. Then I gather you are distinctly in favour of such a central tribunal, to which appeal could be made without any great expense, in preference to settling questions in the ordinary courts of law?—Most decidedly. In the few cases which I have been able to watch, I cannot say I have been impressed with the qualifications of an average bench of magistrates, or even a stipendiary, to decide these questions. He may be an admirable lawyer, but he certainly will not be a chemist; in fact, if he is a chemist, he will not be a good lawyer, because a man cannot know everything.

12730. Have you paid any attention to the question as to whether or not manufacturers should be required to pay a special rate in certain cases on being allowed to connect with the sewers?—I would rather deal with that from the broader point of view that manufacturers are rated already with the most extreme severity, the system of rating a manufactory being absolutely different from that of rating any other property, and they are already paying many times as much rate for the real value of their property as anybody else. A manufacturer pays on what a hypothetical tenant would give for his factory and plant, and I only wish I could find the hypothetical tenant. I should be most glad to grant him a lease of our factory at the rateable value. On the other hand, the cottage pays on a very small fraction of the rent to begin with, and 50 per cent. is allowed for collection, so that already the manufacturer is extremely heavily taxed, most frightfully heavily taxed, and for purposes which, as far as he is personally concerned, as a rule, he only gets a very limited benefit, for the roads, the main roads, are all he wants, as a rule. But education—well, it is fair that he should pay a share of the education for the children of his own workmen, but near London we pay for the education of London clerks. The sanitation is a matter which does not deal with him individually, so already he is paying an immensely large proportion of rates for what he gets no immediate

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benefit, and I think that additional taxation would be a most dangerous evil for manufacturers in England.

12731. Let us consider these two cases: Two firms, A and B, both equally large, both having a correspondingly extensive plant, and both contributing the same amount to the rates. A discharges into the sewers a perfectly innocuous effluent, which does not disturb the sewage system at all. B wishes to discharge into the sewers an effluent which wholly upsets the sewage arrangements unless special precautions and special treatment is adopted. Is B to pay only the same rate as A?—Probably A pays twice too much already.

12732. Do you think that manufacturers are rated above their due?—I have compared the rating in England and in France and Belgium and in Germany, and the weight on English manufacturers is out of all proportion; far the heaviest in Europe.

12733. Suppose A were refused; would you refuse A only. The point is, would you make a distinction between A and B?—Undoubtedly; if A costs nothing to the neighbourhood and B does, he ought to bear it to a certain extent; but it is a vxery different point if an effluent is so injurious that it is impossible to admit it into the sewers at all.

12734. Or with special treatment necessitating expenditure?—Under those circumstances, I think the expense of the special treatment should fall upon the manufacturer, but I do not think it should be by way of rate.

12735. (*Sir William Ramsay.*) That he should do it privately?—That it should be done at his expense privately.

12736. (*Chairman.*) Anyhow, it should be done at his expense?—I think so. But if it is distinctly proved that it is injurious I should be very sorry to give the power to an authority who may be well qualified in other respects, but have not the very specific knowledge to deal with this difficult question.

12737. Well, the tribunal that we were speaking of, having that special knowledge, would be able to judge whether this effluent did require special treatment, and could form some estimate as to what the cost of that additional treatment would be?—Then I think the special treatment, if possible, should be given to the effluent by itself, before it reaches the sewers.

12738. It would be possible, would it not, that the treatment really would be easier after it was mixed with the sewage than before? I mean these chemical problems of sewage are very complex, and it is possible that the treatment might be really easier after mixture with the sewage than before?—It might be; but it would be extremely difficult to exactly measure the difference after mixing with other matters. The problem would be unsatisfactory, complex, and I am sure in many cases it would mean that a burden would be thrown on the manufacturer which would be very unfair. I do not mean local authorities are worse than manufacturers; but they take care of themselves as much as they can, and if the local authority can throw the burden on somebody else they will.

12739. Then, speaking generally, what would you say were the main difficulties which occur between the manufacturers and the local authorities?—Of course, the difficult cases are those where the effluent is distinctly injurious, corrosive, and dangerous, and those cases must be dealt with by themselves. The corrosive and dangerous effluents I think ought to be treated by themselves before they enter the sewers, though it is exceedingly difficult to see what the ultimate result of some additions would be. A little arsenic would probably make the decomposition of the sewage more rapid, but a large amount might prevent it decomposing at all. It is a very ticklish question; but as a rule, the effluent should be purified, and when purified should be admitted to the sewers with as little inconvenience as possible.

12740. (*Sir William Ramsay.*) We were shown yesterday, for example, trade effluent which smelt strongly of hydrochloric acid?—Then that clearly is a highly undesirable thing.

12741. And wasteful on the part of the manufacturer?—It is sometimes. A sovereign at the bottom of the sea is not worth much; it costs too much to get it up again, and you may have an effluent which contains a valuable substance which it does not pay in the least to get out, therefore one cannot always assume that that would pay. Probably the manufacturer would have to neutralise it with lime, and lose it; but it is quite evident that no acid effluent ought to be allowed in the sewers. If anything acid goes in, or anything strongly alkaline, it is exceedingly bad for the sewer.

12742. (*Colonel Harding.*) Then clearly, whatever the condition of the law, it must be a matter of ultimate bargain between the local authority and the manufacturer if the effluent is of a kind which prejudices the sewer or the treatment of the sewage. Then do you not agree that it is fair to ask a manufacturer to carry out some preliminary treatment before discharging it, as a condition of receiving it into the sewer?—Might I make a distinction? I should say it was rather in the old sense of the word a *querela* between the manufacturer and the local authority, and for that reason I would rather have someone in the position of a judge, to decide what was fair between them. If it is merely a question of a bargain, the local authority will always drive a hard bargain.

12743. Well, not necessarily. Many local authorities realise that it is to their interest to promote the trade in their neighbourhood; but it does appear just that they should be able to lay down conditions before receiving effluents which appear objectionable to them?—Of course, if there is an appeal to some independent authority. Many local authorities have a violent prejudice against manufacturers.

12744. (*Chairman.*) You are speaking now from your own experience?—I know from my own knowledge that many local authorities are extremely averse to have factories, from the point of view that they damage property; they would rather have residential property. I think there should be some restriction in a case like that as to what can be done, but I do not think it should be done by side winds.

12745. (*Sir William Ramsay.*) What do you call side winds?—Well, I mean if a local authority have an objection to factories, which they may have for very various reasons, the objection should be honestly stated, that the factory was injurious altogether to the neighbourhood, and not dealt with by making things difficult for the factory.

12746. I think before I came in you expressed an opinion in favour of a system somewhat like the alkali inspection system applied to this quesion?—Yes; I have spoken of that. Not only my own experience, but that, I think, of all the manufacturers I know, is that the Government inspection is, I think I may say, always satisfactory. The position of a Government inspector—the independent position—and his status may not only give a weight to what he says, but gives a character to his mode of dealing with matters which is so satisfactory as compared with that of local authorities that everybody is strongly in favour of a Government inspection instead of one by the local authority.

12747. Are you under the Alkali Act?—Yes, I am.

12748. You find no trouble at all?—We find it a very useful thing to have wise advice if there is a difficulty.

12749. And you find that there is no trouble in dealing with the inspector who will freely tell you as man to man what he suggests as the best way of getting over the difficulties?—Yes; and both with the Alkali Act and the Factory Act the inspectors are wise advisers as well as inspectors. If a factory inspector says that machinery is dangerous, I should never dream of asking questions, because I am certain it is. I have perfect confidence in both the factory inspectors and the alkali inspectors. I have never known of a case which could be considered vexatious or unreasonable interference.

12750. This point has been pretty frequently put to us: Supposing persons similar to alkali inspectors were appointed to supervise generally the whole sewage scheme of the country, and also the trade effluents, such persons cannot take responsibility for advice. Let me put a case. At present there are difficulties, for example, between Rivers Boards and manufacturers. The manufacturer says the Rivers Board wants something done. The manufacturers say: "Tell us what to do, and we will do it." The Rivers Board declines responsibility. Something must be done. Supposing such a case to arise under the Alkali Act; in such a case does the alkali inspector advise the manufacturer from an official point of view, or does

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he merely say, "You must do something; you may take my advice if you like, but you must not hold me responsible if it does not work?—All the inspector is bound to do is to say that there is something amiss.

12751. What does he actually do?—Well, he will actually generally tell you how to avoid it.

12752. And you do not feel inclined to blame him if his suggestions do not come straight?—Oh, no. I have not known them not come straight, but I certainly would not blame him.

12753. Because that is the difficulty we have had put to us?—The most you could ask him is that he should advise as an adviser, but his official duty is to say a thing is, or is not, right, and I think, in the case of effluents, he should have a right to prescribe that a certain thing shall be done, and, the thing being done, the position would hold, the bargain would hold till there was a fresh inquiry. In case of anything going wrong, he could not be held personally responsible by either party.

12754. In Mr. Fletcher's evidence—he has given us evidence—he pointed out that there was no very great trouble in giving advice; it generally amounted to washing the vapours more. The Alkali Act, as you know, applies to the escape of noxious vapours. Most of them get washed out. That is a simple matter, compared with the disposal of trade refuse, which is of the most diverse kind. It might necessitate suggestions which might or might not prove practicable?—I think that the authority should have power to make suggestions, and there is where I have rather suggested that there should be an appeal to a central authority, as to whether those suggestions were necessary. I think there would very soon be a mass of experience accumulated which would settle the question. It generally resolves itself into a question of expense. It pays to recover fat from soapsuds to a certain extent, and it simply is a question of how much is to be allowed to escape; and it pays to save strong acid. It is a question of how much is to be allowed to escape, if any; and, with metallic pollutions in the same way, how much can be allowed, and experience, I think, would very soon decide.

12755. Then you think there should be no definite standard fixed, but some sort of elastic phrase used, such as the best practicable means?—Standards would ultimately have to be fixed.

12756. But, to begin with?—But, to begin with, an elastic expression would be sufficient. There is, for instance, no standard about fencing machinery, but experienced factory inspectors can say in an instant where the fencing is sufficient or not.

Mr. C. A. Davis, called; and Examined.

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12757. (*Chairman*). You are the owner of the Springfield Dyeworks, Greetland?—Yes, sir.

12758. You are discharging your refuse into a sewer?—No, sir.

12759. Not at all?—No, into the stream.

12760. (*Colonel Harding.*) What is the stream?—The Blackburn Brook—a tributary of the Calder.

12761. (*Chairman.*) What is about, roughly, the volume of your discharge in the 24 hours?—From 100,000 to 110,000 gallons.

12762. And does it contain many impurities?—Well, it is very highly coloured, you see, being a dye water, but nearly all with indigo, and what solid matter we have is mostly indigo and Fullers' earth.

12763. Is there a large amount of solid matter in suspension?—A fairly large amount.

12764. Is the reaction of the effluent noticeable at all; is it marked either in the acid direction or the alkali direction?—No, I do not think so. Of course, we use both, but I think the effluent is fairly neutral.

12765. You take your water from the same stream?—No.

12766. You have wells of your own?—Yes.

12767. So that you are under no compulsion to return it to the stream?—No; not the slightest.

12768. Is your effluent considered satisfactory?—Well, I do not think it is, for the simple reason that we have not yet put down tanks to deal with it, except experimentally.

12769. (*Colonel Harding.*) And, as a fact, it goes untreated to the stream?—At present the bulk of it.

12770. And that is not satisfactory?—Well, of course it is not satisfactory, because we have not treated it yet. Last year Dr. Wilson and myself and his chemist carried out several experiments, upon which this report of Dr. Wilson bears. That is, with regard to waste indigo waters. These were carried out at our place to see if it were possible to recover indigo from the effluent, and, so far, it has been unsuccessful.

12771. (*Chairman.*) What is your position with the Rivers Board at present, then?—All right. We intend to go on with the works straight away.

12772. May I ask, are your works of long standing?—Oh, yes; 80 years.

12773. (*Colonel Harding.*) When you say "all right," you do not mean to say they are satisfied?—No; but I mean we have no trouble with them; they have not pressed us yet. Dr. Wilson knows that it is a very peculiar effluent to deal with, and he has not pressed us in the slightest.

12774. (*Chairman.*) But the position is that you are making efforts in order to bring your effluent into a satisfactory condition?—Certainly, yes.

12775. And the Rivers Board are waiting the results of your effort?—The Rivers Board have been helping us just as much for their own information as ours.

12776. (*Colonel Harding.*) Could you tell us something about these experiments for the recovery of indigo alluded to?—Yes; we put down some experimental tanks. That was first a settling tank; then the water flows over a little weir into a filter, through the bottom, to another, over another filter, and we get that water clean enough to use again. In the summer time we are rather short of water, and our object in doing that was to see if we could get the water so that we could use it again, and we are doing so; but that is only a portion of our effluent.

12777. But is there anything to prevent your dealing with the whole in the same way?—We are going to.

12778. (*Sir William Ramsay.*) Is the water coloured after it passes through those filters?—It is coloured, but not so highly coloured, on account of the indigo which has been removed. Of course, with indigo, it is rather different from an ordinary dyer's effluent, because indigo is an insoluble material.

12779. (*Chairman.*) The whole of your colour is indigo, or are you using other dyes as well?—Oh, yes; we are using other dyes as well, but, as far as the solid matter goes, it is indigo. Other dyes only give colouring matter, not solid matter.

12780. (*Colonel Harding.*) Are we to understand that the process you have been experimenting on shows that you could deal with the whole of your effluent so as to purify it sufficiently to use the water over again?—Well, that is what we have already done experimentally.

12781. It is practically to be done?—Yes, I think so.

12782. And that water fit to be used by you over again would be in a condition which would satisfy the Rivers Board?—Yes.

12783. So that the purification of your effluent is practicable?—It is practicable in that sense.

12784. Then, is there anything to interfere with its practicability in the direction of cost?—I must qualify it in this way. We could not treat the whole effluent from aniline and alizarine water, and chrome liquors, and that sort of thing that we should not turn in there. The part of our effluent we should deal with there would be dye water, and simply refers to the whole of the washing machines; that is, washing off the pieces after dyeing; that is the biggest effluent; but from the cisterns—that is, the cisterns where we have been using alizarine colours, or chrome, or boiling out, anything of that sort—that effluent would still go into the stream.

12785. Untreated?—There is no solid matter to treat.

(*Sir William Ramsay.*) But could you not precipitate with lime?

12786. (*Chairman.*) There is a good deal of matter in solution, though not in suspension?—It may be in

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solution, but I do not see how you can deal with the effluent as you suggest, because dyers' effluent is so diversified, and consists of so many different things that, although you may turn out your cisterns, treat them separately inside first, and get your liquor colourless, immediately they meet again you get a coloured liquor.

12787. (*Sir William Ramsay.*) But that liquor contains insoluble matter?—Precisely; the fact of the matter is, I think, that alizarine effluents are insoluble lakes to begin with; they are not in suspension at all.

12788. Would not filtration clear them?—I do not think so.

12789. (*Chairman.*) Then, are we to understand that part of your effluent, namely, that which is coming from the washing plant, you feel able to purify to such an extent that you can use it over again, and subsequently to discharge it to the satisfaction of the Rivers Board into the river?—Yes.

12790. But that is only a part of your effluent?—That is 75 per cent. of it.

12791. 75 per cent.?—That is the objectionable part.

12792. The other 25 per cent. is not objectionable in the eyes of the Rivers Board?—No, I do not think so, except as far as colour goes. It is forced to be coloured; we cannot remove the colour, either by chemical precipitation or land filtration.

12793. It does not contain then—this 25 per cent.—either much solid matter in suspension or matter in solution, only a slight amount of colouring matter?—That is all.

12794. Which gives considerable colour to even a large volume of water?—That is so, yes.

12795. And the Rivers Board do not object to that?—Dr. Wilson does not, personally; I do not know about the Board.

12796. Then, incidentally, was any indigo recovered by the process that you have described to us?—We got a fair amount down, very heavy sludge. The Fullers' earth used in washing acts as a precipitant, and we find in actual working that Fullers' earth is a better precipitant than any chemical we could use, taking down the indigo. But, so far, we have been unable to recover it. We did with one experiment, with glacial acetic acid. That would be impossible in bulk.

12797. (*Sir William Ramsay.*) Could it not be reduced and made soluble and so leave the insoluble matter behind?—No, we cannot separate the Fullers' earth.

12798. (*Colonel Harding.*) As far as recovering the indigo was concerned the experiment was unsuccessful, but so far as purification of the effluent went it was successful?—Precisely.

12799. (*Chairman.*) You would have all the cost of the purification and no return whatever?—None whatever, with the exception of the advantage of being able to use the water over again when necessary.

12800. (*Colonel Harding.*) Are you proposing to carry out this process for the whole of your 75 per cent. available?—Yes, we are, and I may say that is satisfactory to Dr. Wilson who has seen it several times—the system that is working; and he told me that he was satisfied. The amount of solid matter was ·03, I think.

12801. (*Chairman.*) Then, you yourself have no experience with regard to the turning of your ordinary refuse into the sewers?—Not into the sewers.

12802. (*Colonel Harding.*) There has been no question of connecting you with the sewers, has there?—No, except that I mentioned it to the local authority to meet with a point blank refusal.

12803. Clearly, if you were able, without prohibitive cost to purify your sewage to go into the river, there is no great difficulty in purifying sufficiently to go into the sewer?—Well, the cost is a big thing; it would probably cost us £600 or £700.

12804. (*Chairman.*) You proposed to send your effluent untreated into the sewer so as to save you the expense of this purification of the 75 per cent.?—Precisely, I wanted to do that—I mentioned the matter to them, because, being large ratepayers, and other people in the district are using the sewers simply because they were connected with the sewer, and the local authority cannot disconnect them, I thought it was very unfair.

12805. (*Sir. William Ramsay.*) In carrying out these experiments with your indigo recovery, did Dr. Wilson give you any active assistance, or did you devise your process yourself?—Oh! No, Dr. Wilson made experiments himself, and they were carried out at Wakefield, at the West Riding Rivers Board offices, I mean actual chemical analyses, showing that the untreated liquid as it ran into the tank contained 3·08 grams per gallon of indigo, and treated liquid 0·32 of solid matter—that is not bad.

12806. (*Chairman.*) I was about to ask you whether you think that the existing law adequately defines the relative positions and rights of the manufacturers on the one hand and the local authorities on the other?—I do not think it does, sir.

12807. Then what changes would you be prepared to recommend or suggest?—Well, I think that they ought to be equitable.

12808. Do you think, for instance, that the manufacturers ought to have greater rights than they have at present to connect up with sewers?—I do.

12809. That all of them should?—All or none; but I think all ought to be allowed to connect up.

12810. Without regard to the nature of their effluent?—Yes.

12811. It is so, is it not, that the effluents differ in the facility with which they are treated after they become mixed with the sewage?—Oh, yes, they do differ.

12812. And would you treat an effluent which required no great expenditure on the part of the local authority in the same way as an effluent which put the local authority to expense in the additional treatment of its sewage after the effluent had reached it?—It would have to be treated in the same way; but I do not see that the rating should be the same. The man whose effluent is the hardest to treat should pay the most money.

12813. You would have a differential rate?—I would have a differential rate, yes.

12814. Depending upon the difficulties and expense necessary in treating the sewage, or after the effluent had been mixed with it?—Precisely, yes.

12815. Are there any further safeguards that you think are required in order that the refuse should be admitted properly into the sewer?—I do not think so. I think the local sanitary authority have every power vested in them.

12816. There are two features, are there not, with regard to an effluent discharged into the sewer; one is that it is desirable that it should be fairly continuous, at all events, not too greatly intermittent. An effluent which is very intermittent, which comes down in torrents at one time and ceases to exist at another gives very great trouble to a sewage authority?—Yes.

12817. That is one point, and the other point is that there are chemical substances in this or that effluent which interfere with the purification of the sewage?—Yes.

12818. You think no special safeguards are required either in one direction or the other with relation to one point or the other?—Well, with regard to the effluents coming down in different quantities, I do not see that it would be possible to do much there. The only thing you could do would be to construct huge tanks so as to let it run off at so many gallons per hour.

12819. Need they necessarily always be huge?—Oh, no. I think the quantities really, taking the whole district together, the flow between six and six would be practically the same each day; it is not so irregular as one would think.

12820. But would there be insuperable difficulties in the way of the manufacturers being able to store their effluent in such a way as to ensure that the discharge should be fairly regular?—They may not be insuperable, but in some cases I think it would be almost impossible.

12821. (*Colonel Harding.*) Why?—Because there are plenty of instances; plenty of mills where they have not a square yard of land to do it, and they are turning out a large effluent, and, for instance, ourselves; we are turning out 100,000 gallons per day; to construct tanks large enough to regulate our fall into the sewer would practically cost as much, and be as big an undertak-

ing as treating the whole thing and letting it go into the stream where it is.

12822. (*Chairman.*) Have you any suggestions to make as to whether safeguards are required. What do you think of the safeguards that are required? What are the conditions which should be satisfied in order that the effluent should be allowed to pass into a sewer?—Well, I do not know; I think that the effluent ought to be taken just as it is, and the local authority have quite the power to say whether it is satisfactory or not. In some cases where the effluent may be very thick, or as you mentioned a little while ago, chemically unfit to go into the sewer, they have the option to refuse it.

12823. (*Sir William Ramsay.*) In your own case, do you turn out your effluent in rushes or pretty uniformly?—It is pretty uniform.

12824. (*Chairman.*) Do you think generally that manufacturers would be prepared to adopt means for the removal of suspended solids and such things as grease from their trade refuse before being allowed to discharge into the sewer?—I believe they are, a good many of them are willing to do it. As I say in my reply, providing that they are exempt from the local sewage rate. I mean in this way that in almost every local authority some manufacturers have established their right to turn into the sewer, and others probably much larger ratepayers will have to deal with their own. It is obviously unfair that they should have to be at an annual expense, besides putting down a fairly large capital to treat their effluent, and, at the same time, paying a big contribution towards the treatment of others. I know one case in point in our own district. Two dyers, both in the same trade, one man turns into the sewer, and he is not put to a penny of expense.

12825. He turns his untreated refuse into the sewer?—He turns his untreated refuse into the sewer, and in the other case his competitor is a larger ratepayer at the same time he is having to treat his effluent.

12826. Why is the distinction made in those two cases? The first case had a prescriptive right?—Well, simply the firm that did not turn into the sewer is the older firm; their place was built before the sewer was built there; they turned into the stream because the stream was convenient. At the place that was built later they simply turn into the sewer, because it was the most convenient way of disposing of their effluent at that time. They had not any idea of any trouble of this kind, so that they have been lucky.

12827. (*Mr. Power.*) The second firm do not obtain any water from a stream?—No; in both cases they get water from their own stream.

12828. But one turns it into the stream, and the other into the sewers—the effluent?—Yes, sir.

12829. (*Major-General Carey.*) If the manufacturers who were turning their untreated effluent into the sewers had to pay some contribution towards the cost of treatment, the unfairness would disappear?—Precisely.

12830. Your suggestion is that they should not pay any sewer rate at all?—What I suggest is this, and what I do stick to is that those who have no benefit from the sewers in the slightest——

12831. But your sewage is treated quite independently of trade refuse?—Oh, yes, domestic sewage is treated, but in regard to trade effluent in the two cases where one man is turning into the sewer and the other is not, the man who is turning into the sewers ought to pay for the right of doing so; he ought to pay for the use of the sewer, because if he does not it is very, very hard lines that the man treating his own ought to have the expense of treating his own, and at the same time be contributing towards the expense of treating his rival's effluent.

12832. It is not probable is it that the local authority would consent to exempt any manufacturer from the sewer rate independently of treatment of trade refuse?—No, it is not probable.

12833. (*Chairman.*) Your argument rather is, is it not, that the firm which is discharging noxious refuse into the sewer should pay more than the ordinary sewer rate?—Yes, I think it could be apportioned.

12834. (*Sir William Ramsay.*) But take the case of your own works, I suppose there are water-closets, or what are equivalent to them, which discharge into the sewer for the use of the workpeople?—No; all the domestic sewage on the place is on the tub system; we have no water closet going to the sewer at all.

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12835. Then you do not make any use of the sewers?—We make no use whatever.

12836. (*Major-General Carey.*) Slop-water goes to the sewers?—No, that goes into our own drain.

12837. Nothing goes into the sewer?—Nothing goes into the sewer.

12838. (*Chairman.*) Are there many manufacturers in your neighbourhood in the same circumstances not using the sewers at all?—Yes.

12839. And discharging into a stream?—Yes, the bulk of them.

12840. (*Colonel Harding.*) You pay a sewer rate?—We do; we have had to pay our proportion. We are one of the largest ratepayers in our district, and with regard to the works that have been put down, and new sewers that have been laid, we have had to bear our share of the cost. Money has been borrowed to construct these works, and I suppose our rateable value is mortgaged for it. We have not a halfpenny of benefit by it, and we have paid rates ever since rates were levied in the district.

12841. (*Chairman.*) And you are not singular in that?—No, we are not; no, in our own immediate district I believe that 70 to 80 per cent. of the manufacturers are on that basis.

12842. (*Mr. Stafford.*) Are your works very near the river then?—Well, the sewer runs down the side of the works; the sewer is nearer to our works than the stream. The works were there before the sewer.

12843. It would be the more convenient to connect with the sewer than it is with the river?—Well, the convenience would be about the same. We have no advantage; in our own case we have absolutely nothing to gain from connecting with the sewer, that is, if we are compelled to remove our solid matter, or as one of your questions puts it, if we had to remove all suspended matter before being allowed to discharge into the sewer our effluent would be in such a condition then to satisfy the Rivers Board; and the sanitary authority having the power to insist on it (they are not likely to favour the manufacturers in the slightest), they would require that effluent to be so clean that it might just as well go into the stream where it is.

12844. (*Chairman.*) Would the sewer authority, do you think, demand the same amount of purification as if the effluent were being discharged into the stream?—I think they would, because I do not know of any sanitary authority that have sufficient plant, and have been quite successful in dealing with the effluents they already have to treat, and if they are compelled to accept manufacturers' effluent, it will be against their wish at present, and I am inclined to think that they would insist on having everything as good as they can possibly get it. There are so many loopholes according to my reading of the Rivers Pollution Act; there are so many provisos that is that the effluent shall not damage the sewer, or if the flow is more than the sewer can take, or if your sewage would interfere in the slightest with their order, they can refuse to deal with it. Well, I think under that Act any sanitary authority can by either one clause or another refuse to take your effluent at all, either that it is too big for them or that it is not of sufficient quality, not of good quality for them.

12845. Have you any views as to the desirability of the existence of a central tribunal to whom appeal should be made in difficulties between the authority and the manufacturers, or do you think the present system of bringing it into an ordinary court of law is satisfactory?—I do not think it is. I think there ought to be a Central Board, but it ought not to be a Rivers Board.

12846. Why not a Rivers Board?—Well, because a lot of disputes, the bulk of the disputes are probably between the Rivers Board and the manufacturers, and it would hardly be fair, I think, to refer a question between a Rivers Board to a Rivers Board.

12847. (*Colonel Harding.*) That is hardly the point, the point was in relation to appeals between the manufacturers and the local authority?—Well then, in that case, I still speak of it that ought to be an independent board, not a board of representatives from different Rivers Boards for instance.

12848. If you had a dispute with your local authority, you would have no confidence in appealing to your own

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Rivers Board?—I do not think so, because our Rivers Board would certainly be biassed on the side of the local authority; I think they naturally would be.

12849. Biassed in favour of the local authority?—Yes.

12850. (*Chairman.*) But have you any definite reasons for that opinion?—No; except these.

12851. The Rivers Board have certain functions allotted to them, and often more or less of a judicial character?—Yes.

12852. And they have to decide on this and that question; surely their duty is simply to decide the question. If they favour the local authority, is not that an indication that the local authority is more often in the right?—Possibly so, but still the law is that the effluent must be purified, must be treated, and the West Riding Rivers Board, I take it, are the body to see it is done. If a dispute comes between local authorities and manufacturers as to who is to do it, I think the local authorities have sufficient loop-holes that the Rivers Board would fall on to the manufacturers. I do not think you could compel the local sanitary authority under the present law to do it so easily as you could compel the manufacturer.

12853. That really is the condition of the law, and not the existence of the Rivers Board?—That is the present condition of things.

12854. The present condition of powers of the Rivers Board?—Yes.

12855. As defined by law is said rather to be in favour of the local authority?—Yes, I think so.

12856. (*Colonel Harding.*) You yourself would have a greater confidence in appealing to a bench of magistrates or a stipendiary or quarter sessions?—Yes, I would.

12857. (*Chairman.*) But would you not have still greater confidence in some central independent board?—An independent board; yes, I grant you.

12858. A Government board for instance?—Yes, a Government board, but not drawn from the different Rivers Boards.

12859. You mean a Government Department, and not one which was elected by the several Rivers Boards?—Precisely, strictly independent.

12860. But you would have complete confidence in a board which was really a Government Department?—Yes, I think so.

12861. With adequate technical knowledge to settle all those questions?—Yes.

12862. I think what you have already said disposes of the question; should manufacturers be required to pay a special rate or charge in those cases where they are allowed to connect with the sewers. If so, how would you suggest that amount should be determined?—That is simply what we have said before. I think that those who connect with the sewer ought to pay for the treatment of their effluent, and those who are not able to connect with the sewer or in those cases where the local authority do not accept their effluent whatever condition it may be in, I do not think that they ought to have to pay their share towards the treatment of others. I think the question as to how it should be done—well, that is a very difficult question. You see you could not rate a person on the present basis of rating, because we will say a manufacturer with 1,000 horse power is a very heavily rated man. His effluent may not be above 100 gallons per day, or say 500, whereas you get another works, for instance, scouring, grease scouring, where they have a very foul effluent and a large one, where they probably have not more than a 10 or 15 h.-p. engine, and are practically small ratepayers, so you get the large ratepayer, the man who is assessed probably at £500 or £600 a year in rates, whose effluent could be dealt with practically at no cost, and you get a man paying £20 a year, whose effluent will cost 100 times as much to treat. That is where the hardship comes in now with regard to rating.

12863. Is it beyond possibility to arrange a special rate, which should be based on the expense to which the local authority would be put by the special treatment of this special effluent?—I do not think it is beyond possibility; I think in almost every district terms could be come to, and would have to be made individually—that is, between the local authority and each individual manufacturer, dealing immediately with his own effluent; I mean to say that an expert or some person could be appointed who would assess.

12864. The tribunal might be consulted?—Possibly, yes, that would be one thing certainly in which they would be useful, that is, providing that the manufacturers who use the sewers pay according to their effluent. I think they ought to, and I say now that that could be done by means of either your tribunal or an expert appointed, who would see the effluent, and assess it just as we are assessed now by one person for poor rate, or anything else, assess your effluent, and charge you accordingly. The local authority would have to deal with each manufacturer separately; it could not be a general basis.

12865. (*Sir William Ramsay.*) What do you actually pay rates on at present? You speak of a man who had a 1,000 horse power engine having to pay higher rates?—Yes.

12866. Is he not rated according to the amount of land that his property covers?—That is a small amount; the highest rating is according to the number of machines, the horse power.

12867. Is that how it is done?—That is the rating; certainly the amount of land you cover is a very small item compared with the power.

12868. So that you want a differential basis for rating?—A differential basis.

12869. Is it a low amount for sewage?—For sewage, in some districts it is very large; in Brighouse, for instance, the amount of the rate directly due to their sewage scheme is 3s. out of a total of 8s. 10d.

12870. (*Chairman.*) It is that special rate for sewage that you are alluding to?—Yes; about 3s. in the £.

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Mr. Walter Francis Reid, C.E., F.C.S., F.I.C., called; and Examined.

12871. (*Chairman.*) You are a Civil Engineer, a Fellow of the Chemical Society, a Fellow of the Institute of Chemistry, and Vice-President of the Society of Chemical Industry?—Yes, sir.

12872. You have had a good deal of experience on the question of trade refuse and sewers?—Yes, I have had a good deal to do with that.

12873. May I ask you, in the first place, are, in your opinion, the positions and rights of manufacturers and local authorities under the existing law adequately defined?—I do not think they are.

12874. Have you had that brought before you definitely in cases?—Yes, I have had many cases. I am a vice-president of the Society of Chemical Industry, which has a great number of members engaged in technical pursuits, and we have had a number of communications from various members. I have a number of them here, and they have expressed their views very clearly, apart from the personal experience I have had in the matter.

12875. Have you found that contradictory decisions have been given?—Yes; that has often been the case.

12876. Can you refer to any of those specifically?—I think I would rather not refer to any particular case. I think, perhaps, the reason of some of the decisions which are contradictory may be that there are special powers in different districts belonging to special boards.

12877. Private Acts?—Private Acts, yes; but the broad result of that is that the manufacturer in one of those districts is really working his factory under different conditions, and, perhaps, less advantageous or more advantageous, as the case may be, under different conditions in any case from his trade rivals, who may be in other districts. I think that is the general cause.

12878. Do you think that the law should be altered, so as to give manufacturers greater rights than they possess at present to connect up with the sewers?—Generally speaking, I think so.

12879. You think the present facilities are not adequate?—Not in some cases—decidedly not.

12880. Then, if the manufacturers are allowed greater rights to connect up with sewers, are you of opinion, on the other hand, that the local authorities should

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demand certain, or should possess certain, safeguards with regard to the discharge of the refuse?—Yes, certainly.

12881. There are two points of moment, are there not? One is the regularity of the flow: some works discharge their refuse with great irregularity; they give trouble to the sewer authority from that very irregularity, that is one point, and then the other point is the constituents of the sewage, which may interfere with the purification of the sewage or damage the sewage system?—On the point of the regularity of the flow of the effluent, there seems to be at present in some districts an amicable arrangement between the manufacturers and the authorities. I have two letters from members of our society, who say that they have arranged at their places the flow of their effluent with the manager of the sewage works. Of course, that would only be possible in a comparatively small place, but I think it would be reasonable, and I have not heard of any objection to the flow being discharged with a fair amount of regularity.

12882. It means building storage tanks, or something of that kind, does it not?—Undoubtedly, in some industries it would mean a considerable capacity of storage tanks, but, on the other hand, it would hardly be reasonable to expect an authority, say, in a small district, with very large works, to construct sewers of an enormous capacity, if it could be obviated by a storage tank.

12883. But there is a difficulty, is there not, in certain cases of old established works, situated in the middle of a crowded town or city, that they have no land upon which they can erect a storage tank?—No, they have not the land. I think the difficulty would always arise with old established works. Whatever remedial steps are taken, there would always be a very great difficulty with those. It would be unfair to put restrictions upon them after having been going on for a number of years, carrying on their trade in a certain way; I think it would be unfair to impose upon them conditions which might well be imposed upon other works or new works.

12884. But are they to be allowed to continue to upset, so to speak, the sewage system by their intermittent flow?—I do not think that would be right, but I think in many cases with old established works, the course might very well be adopted that was adopted with the Explosives Act of 1875, of which I have special experience. When the Explosives Act was passed, certain arrangements were imposed on all explosive factories, but those factories which were at the time in existence were granted what was called a continuing certificate, and under that continuing certificate things were allowed to be done, or buildings were allowed to be used, which were not permitted to new factories. That might possibly be adopted in the present case in the case of some works, I will not say to carry on all the operations that they carry on now, but, at any rate, some of them.

12885. Then, can you make any suggestions as to any further safeguards than those we have spoken of, which should be required by the local authority?—With regard to the purification of sewage?

12886. Yes?—Well, I think the authorities may reasonably ask that no solid particles that would be likely to be deposited should be allowed to enter into the sewer. I understand that is so under the Rivers Pollution Act, but it seems difficult to find out what that Act really does impose upon manufacturers.

12887. Do you think manufacturers are prepared to adopt means for the removal of suspended solids, and grease, and so on, from their refuse?—All would not, but I do think all the more reasonably disposed of them would do so; I think they ought to be required to do so in the public interest. That is my own view. I have no doubt that some of our members would object to that view, but, still, I think it is only reasonable that he should not discharge into the sewers anything that might interfere with the flow of the sewage. It would be against their own interest, as well as that of their neighbours.

12888. Then, in cases where difficulty arises between the local authority and the manufacturers, is it adequate to take those difficulties before the ordinary court of law, or do you think there would be any advantage in the institution of some central tribunal, as the court of appeal, between the two parties?—I think the present state of affairs is most unsatisfactory. It is expensive, and, when the whole battle is fought, there is probably a decision arrived at which is no help to any one else, and sometimes does not settle the very point that has been raised in the special case. If a tribunal could be constituted that would be acceptable to all parties, I think it would be of very great national advantage. I have made some mention about the course that is pursued in Germany about it.

12889. Would you state now that point?—It was chiefly in connection with the insurance of work people that the German Government instituted a system of incorporating each trade into a guild, what they call a "Berufsgenossenschaft," and those guilds are now practically the organised voice of each industry, so that the Government there has the means of obtaining the views of each industry. Practically, there are no means here now; of course, a Commission like your own is a very valuable means of eliciting public opinion, but it is hardly complete enough throughout the whole country, and the result of the reports of very important and influential Commissions, who have had most valuable evidence given before them, are not acted upon, because, perhaps, at the moment when the legislation is being carried out, some influential member of Parliament may get up, or somebody may have political influence with the Government, and then measures which have been recommended, and which otherwise would be accepted, probably are not carried out, whereas, if the trades were represented in some way, those who might otherwise object would have been heard beforehand, and they would have no reason to object, and I think that if such a course were adopted it would happen as it does in Germany, that the conflicting interests in the trade are quite sufficient to ensure fairness in their recommendations.

12890. You would definitely recommend, would you, the institution of some such bodies?—I think it would get us not only out of this difficulty to some extent but out of a great many others.

12891. A guild for each particular trade or industry?—For each industry.

12892. (*Sir William Ramsay.*) Would it be possible to establish such a thing; it would require to come from the industry itself, as it no doubt did in Germany?—No, in Germany the Government said to the manufacturers, "You must organise yourselves, because the risks and the compensation to workmen will have to be according to the trade they are employed in, and you must organise yourselves." I do not quite recollect the conditions under which they were organised, but, of course, you will be able to obtain information of that kind. They did organise themselves, and these bodies exist, and they are found most valuable, because in the technical literature you continually find them referred to.

12893. (*Chairman.*) But was not the fact that the guilds existed first, and then the Government made use of them in this way?—No, sir, I remember the institution of them; that was not so.

12894. Definitely instituted at the suggestion of the Government?—Yes, in connection with the insurance to workmen, I believe.

12895. Is there anything similar in France?—In France there is an inquiry held, I believe, where a new factory to be erected. I think it is called the *conseil de prudhommes.* They hold an inquiry as to the erection of a new factory in a commune.

12896. It is also the nature of a guild?—I believe they are more in the nature of official experts, but they are consulted by the communes, and the communes have the right to impose conditions. I am not so familiar with the practice there as I am here with the Explosives Act, and that is the only case that I know of in this country where an inquiry is held. If you wish to establish an explosives factory in any particular district, you get a draft license from the Government. The Government say you may erect a factory under these conditions. Then the draft license is submitted to the local authority for their assent or dissent. Then the local authority may impose conditions. If the manufacturer accepts those conditions, then the license will be granted finally by the Government; if he does not accept those conditions, then the Government may grant the license over the head of the local authority, if it thinks fit. It is really a court of appeal, and it may accept some of the conditions which have been proposed by the local authority and impose them on the manufacturer before he erects his factory. There are several ways out of it, but, I believe, that is the only case in this country

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where an inquiry is held, and I think it might be possible in cases of certain industries, in the first instance, to hold an inquiry of the kind before the factory is instituted. It would get over many cases of great injustice.

12897. (*Sir William Ramsay.*) What body holds such an inquiry?—Here?

12898. Yes?—The Home Office, in the first instance; the Explosives Department of the Home Office. They make a general inquiry, under the Explosives Act, as to the site, whether it fulfils the conditions of the Explosives Act, and all the conditions which they might impose, and then they issue a draft license, so they hold the inquiry first.

12899. (*Mr. Power.*) Is there a public inquiry at which persons interested may appear and make representations?—Yes. It has to be advertised for a certain time in the local newspapers.

12900. Then both parties, the people proposing to set up the factory and the local authority, have an opportunity of saying their say before a Government official holding the inquiry?—After the Government have held the preliminary inquiry, but before the Government decide upon granting the final license.

12901. But do they take evidence; do they hear witnesses on both sides?—Oh, yes, on both sides and any one.

12902. Anyone interested in the subject matter of the inquiry can make a representation?—Yes. I heard one gentleman object once before such an inquiry, because it would raise the rate of pay of his farm labourers; he was admitted to give evidence.

12903. (*Chairman.*) Are you suggesting that there should be some such similar process with regard to every manufacturer?—No, not every manufacturer.

12904. But one which is likely to interfere?—One which is likely to interfere either with—perhaps I am going beyond the scope of this Commission if I say—the air or the water, but the air is as important to us as the water sometimes.

12905. Have you any doubt as to whether manufacturers should be required to pay a special rate or charge in these cases, where they are allowed to connect with the sewers?—Well, I have not heard of one view in favour of such a course, but I have heard a great number of complaints that the rates at present are extremely heavy on some manufacturers, that they not only have to pay for all these sewers, but that they have in addition to pay for purification which they carry out at their own factories, of course it depends upon the local conditions; it depends entirely upon the local conditions. If the manufacturer is in a small way, and he is a ratepayer in a large town it does not affect him so much, but in other cases where the manufacturer's contribution forms a very large proportion of the rateable value, then it may be extremely heavy on him, and if he were then in addition to spend a very great deal of money on purifying his effluent, it would very seriously affect national trade generally, I think.

12906. On the other hand, this state of things is possible, is it not, that there may be two manufactories, one of equal size paying upon horse-power and so on equal rates, one would discharge into the sewer a relatively innocuous effluent, and the other would discharge the same volume of very noxious effluent; the one I mean would cost the local authority very much more than the other; is it fair that they should both pay the same rates?—Well, it is quite possible that the difference is only apparent; for instance, take the paper making trade, which is a most difficult trade in which to get rid of the effluent; you may have a paper maker in the town, and alongside of him you may have an engineer who makes paper making machinery, not only for that town but for a great number of others; the paper making machinery maker discharges no effluent at all, but at the same time he is producing the means for others to do it, and he is getting his profit entirely out of such factories. If it were possible to average the thing over the whole country, then, of course, no injustice could be done to individuals, but that is the difficulty, of course.

12907. What would you say were the main difficulties the manufacturer meets with in dealing with local authorities?—Well, there are a good many, but I think the chief is that the local authorities do not quite realise the conditions under which the manufacturer has to work, and that they are not sufficiently familiar with the technical processes that he carries on, nor with the very great influence which small modifications in his processes may have upon his trade; in fact, the members of the local authorities themselves are not always technically educated, and their officers, as a rule—I have come into contact with a great many of them—are highly educated gentlemen as a rule as engineers and in other branches, surveyors especially, but they have very rarely worked in factories, and they do not know the difference between a process carried on in one, and a process carried on in another. I can give you one or two instances, some of which are rather amusing, but when a man is fined heavily for it, it ceases to be amusing to him. I was in one case where a manufacturer was fined, it was not in connection with the water, but with the air—the man was fined for emitting black smoke at night. Well, there was not a particle of smoke went up the chimney. It was a dense cloud of steam, but the surveyor who gave evidence did not know that a cloud of steam at night is just the same as a cloud of black smoke; perhaps it looks a little blacker. I know the circumstances of the case; he could not have emitted any smoke at the time. Another case that I have personal knowledge of was an inquiry which was held on a large chemical factory, and a committee was named by the local authority, and I had to meet these gentlemen, and I tried to find out which was the man among them who understood manufacturing operations—who was the expert—and I was pointed out one gentleman, and the qualification that was mentioned was that he kept about two dozen pigs. That was what actually occurred to me. It was a case of nuisance, and this gentleman was simply an authority—supposed to be an authority. Those may appear comical, but it is a serious matter when things are imposed upon manufacturers under such conditions, and I have no doubt that many others could give similar cases throughout the country. It would be an advantage if we had some tribunal that could be appealed to in such cases, or if we had some means of advising local authorities in the first instance. There is very great waste under existing conditions, both with regard to the expenditure of public money, and the expenditure of capital on the part of manufacturers. The money that is wasted now would pay the expenses of a very expensive tribunal indeed.

12908. You are very distinctly then in favour of such a tribunal?—Most decidedly.

12909. Have you any experience with reference to the use of the water at manufactories, and the return of the water into the stream. Some manufacturers, of course, draw their water from the stream, and they are bound to return the water into the stream?—In these cases, of course, the bulk of the water must go back. In some cases where the riparian owners or the local acts force them to do so, it may be an injury rather than a benefit, because a man may have a small quantity of effluent which is extremely obnoxious and concentrated, and might be easily dealt with, but he cannot because the liquid has to go back. That is one point about it, but I think the most important point about it is with regard to the total flow of water. I think that is the point upon which you wish to have my views.

12910. Yes?—With regard to the total flow of water in the streams; where a stream is already polluted, in many cases the manufacturer has to have recourse to well water, for any water that is fit to use at all, and that water goes into the stream, and in that respect it increases the flow. There are some places, I think I mention one or two, in Leeds for instance, they use chiefly well water, and in other cases also they rely for the bulk of their pure water on well water. You are taking the water from the water-shed of the stream; it does not increase the total flow of water in the water-shed, or the river, which it runs into, but it does at the spot; it makes up for what water may be abstracted—the bulk of the water used, I think, must ultimately go into the stream again lower down, except the small quantity of water that is evaporated or goes out in the form of combined water, that which goes off in steam is not returned.

12911. Generally do you think that any alteration of the law is desirable so as to get over any of these difficulties as to riparian rights?—It differs so much in different cases. Where a manufacturer is obliged to return all the water his condition is quite different from a manufacturer who can take water and then

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purify it, or return it or not as he thinks best or the local authorities wish. The conditions are so different, I do not think one could make any statement generally.

12912. (*Sir William Ramsay.*) Are there many disputes as regards riparian rights; is it a subject that often comes up before the Law Courts?—Very frequently, I have had myself to give evidence in many cases, but not so much local authorities, of course, as individuals; it is generally one individual fighting against another. I was in one case—this refers to a question you asked me just now about other cases; I was in one case in which a manufacturer wished to put up a factory, but before he did so there was opposition on the part of the owners of a fishery. Before he did it there was an attempt to get an injunction. That was a fight between two individuals; the local authority did not come in.

12913. I was not thinking of that sort of case so much as a manufacturer who abstracts water from a stream which he does not return to the stream, and so deprives his neighbour down below of the water; does that dispute come?—I have not personally come across those, but in the midland districts I believe they are pretty frequent. I have heard about it from other members of our society.

12914. I want to ask your views about some sort of system similar to that of the administration of the Alkali Acts applied to sewage and trade effluent; do you think it would be a good thing to have a body of men somewhat like the alkali inspectors to go about the country, and report and advise the manufacturers as to how to dispose of their trade effluent, or warn them that they are exceeding a certain limit, when their process is not as good as it might be?—Well, I know we have a great deal of experience of inspectors' work, both in connection with the Explosives Act and with the Alkali Acts, and on the whole, undoubtedly the action of the inspectors has been beneficial in both cases, and we are extremely fortunate in this country in the gentlemen that we have as inspectors. The explosives inspectors have done very much to raise the explosives trade in this country, and they are generally willing to assist the manufacturer. But they are in a very difficult position. They cannot, and I think they ought not to tell one manufacturer what another rival manufacturer is doing in his factory, and unless they can do that they are not in a position to advise manufacturers.

12915. But this would hardly be open to that difficulty; because after all the disposal of refuse would not involve the revealing of trade secrets?—It may mean in some cases the difference between profit and loss to a manufacturer—say a tannery. There are patents which depend for their existence upon the difficulty that exists in the neighbourhood of getting rid of the refuse. The case might arise; I do not say that it would, but it might.

12916. In your experience of alkali inspectors, I suppose you do not find that they meet with any practical difficulty in giving advice?—Well, I think there is that moral difficulty that they are really under an obligation not to divulge the processes that they see.

12917. And they do not?—And they do not as a rule.

12918. But they obviously help the manufacturer very considerably?—They do certainly; I admit that, but I am not quite sure whether it would be a beneficial arrangement upon the whole to rely upon inspectors for assistance to the manufacturer, and of course, there is this difficulty also. There is a well-known gentleman in the chemical trade who was an inspector, and he thought he would rather retire. Well, he retired from being an inspector, of course, and then he could advise other people about things he had seen in the factories of different manufacturers. I think it would be well if there was some means of advising manufacturers, but if they were organised each one would be able very much better to find out the means of disposing of their trade waste, not only effluents, but gases and other products; they would be able to do that very much better than could be done by any general Government system, I think, because they would have the special knowledge required. They would know their own special wants. And one of the advantages of the American system of Trusts is that all new things are tested, and they have the means of doing it. That is only through their system of organisation. I do not recommend trusts, of course, but I do recommend the organisation of those engaged in special trades, because then they would have the means. We have done it here in connection with brewing; with the leather trades to some extent there is a partial organisation, and they are very useful indeed these organisations, as you know there is an institute of brewing.

12919. Yes; it appears to be an extremely difficult thing to bring about. Manufacturers might be privately told it would be desirable, but would such telling produce any effect whatever?—I am rather inclined to think that our manufacturers, if they were urged to, would be able to do what the Germans have done.

12920. Are we so much in the habit of organising as the Germans are?—There is more left to individual effort in this country, it is true, but we find now, in their competition with the trade of the world, that we have to organise. If we do not organise ourselves, we have the Americans come over the Atlantic and do it for us.

12921. But I do not see how to begin it; would you have the Government send round a circular, suggesting organisation, and stating that some penalty would be inflicted if they did not organise; I do not see how they would start?—I do not quite know; I am not familiar with the actual method of starting it in Germany, but, if you call me again, I will inquire, and get it for you. Through the Foreign Office you could get the whole details, or I shall be very pleased to summarise them for you.

12922. (*Chairman.*) If you, at your leisure, could put in a little memorandum for us on that point?—I shall be very pleased to make inquiry, and to do so. It is a practical difficulty, of course, and our manufacturers probably at the beginning would not very much like to have it officially imposed upon them to do it unless it were put to them that it was to their advantage.

12923. It is now officially imposed in Germany?—Oh, yes; they have to belong to one of these "Berufsgenossenschaft.

12924. (*Sir William Ramsay.*) They do organise here for the purpose, it appears to me, of defeating the schemes of the Rivers Boards?—It would be very much better if they were to organise to help the Rivers Boards.

12925. Certainly?—There is a question here which I have not referred to about Rivers Boards. I do not think a Rivers Board would meet the point at all; I think in one of your questions it is mentioned.

12926. (*Chairman.*) It is a Central Government Rivers Board, not a Local Rivers Board?—A Central Board would be preferable, because I think the Local Rivers Boards are rather inclined to inflict hardship on manufacturers.

12927. You have some experience of their work?—I have of the Thames Conservancy. I happen to live in a village not far from Weybridge, where we have not been able to have a sewage system at all. In this time of day we ought to have a sewage system, but we have not been able to, because of the opposition of the Thames Conservancy. On every occasion that we have tried to get up a sewage scheme, which would have been passed in any other part of the country, we have had very great difficulty. It is only quite recently that we hope to be able to effect it, we have not got it yet.

12928. But surely the larger Rivers Boards are not. For instance, the Mersey and Irwell, whose action has been directly in support of sewage disposal and has had very beneficial action?—Well, certainly, there is no doubt that they favour, and, of course the Mersey and Irwell have rather different objects in view to the Thames Conservancy. They look after the navigation as well, do they not, to a great extent; it is chiefly the navigation, is it not? I know it is a very important point, because I recollect being out of sight of land at the mouth of the Mersey, and I saw a great mechanism looming in the distance, and I heard it was one of their dredgers. That is the Conservancy Board.

12929. But you have no direct experience of the Mersey and Irwell?—No, not of the Mersey and Irwell. I have only had the general experience that those who visit the district have, that whatever the Board is, whatever the conditions are, the rivers are in a terrible state.

FORTY-THIRD DAY.

Thursday, 3rd July, 1902.

PRESENT :

The Right Hon. The EARL OF IDDESLEIGH (*Chairman*).

Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Colonel T. W. HARDING.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS (*Secretary*).

Mr. HAROLD MARSHALL, Mr. C. W. CROSSLEY, Mr. PERCY GRATRIX BALDWIN, and Mr. JOHN SMITH, called; and Examined.

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12930. (*Chairman.*) We may take it that you have come here this morning as the representative of the Halifax Traders' Committee?—(*Mr. Marshall.*) Yes.

12931. Now, in your opinion, are the positions and rights of manufacturers and local authorities under the existing law clearly defined?—Yes, under the Public Health Act, and the decisions which have been given in reference to manufacturers and local authorities.

12932. Then you are not of opinion that the law ought to be altered so as to give manufacturers greater rights than at present to connect up with the sewers?—First, would you prefer that I should amplify that answer in any way, because I will do so before I go on to the next question. With regard to the decisions I refer the Commissioners, so that they might at any rate have it on their notes, if they have not. One of the decisions to which I refer is Ainley v. the Kirkheaton Local Board, 60 L.J. Chancery, 734. That was a case under section 17 of the Public Health Act, which was decided in favour of the manufacturers. Then there is Peebles v. Oswaldwistle Urban District Council, 1896, L.R.I., Q.B.D., 392. I should think you probably have that upon your notes. That is under section 21. And then there is a later case, Eastwood v. Honley Urban District Council, 1900 (Ch. Div., 781). That was under section 21 of the Public Health Act. The effect of these decisions is that a manufacturer having sewers near his property which he can go to as a ratepayer under the powers of the Public Health Act without trespassing on other people's land, without requiring facilities in other words, that he is entitled to go into the sewers and to use the sewers to their utmost capacity, and to put in all kinds of sewage including manufacturing effluent. That is the effect of those decisions. The Eastwood case followed the Peebles case, and was decided on that portion of the Peebles case which dealt with that. Well, then, the other part of the law is under the Rivers Pollution Prevention Act, where local authorities are compelled to give facilities subject to certain restrictions. Under the Rivers Pollution Prevention Act the facilities do not go quite so far as the rights under the Public Health Act, but that is the distinction. The distinction is this, as far as I have always thought, and have been advised by very eminent counsel from time to time, that it is sound, and that is that where you require facilities you are not quite in such a strong position as where you are a ratepayer having a sewer running by you—that is to say, if there is a sewer in the street running by you that you have not to go across another man's property to get, you have not to come to the local authorities for facilities to get to it, you do not require to come under the Rivers Pollution Act. It is only when you require facilities, and in that case there are certain restrictions. Then in the West Riding of Yorkshire we have, as no doubt the Commissioners are aware, a special Act—the West Riding Rivers Act, 1894. The facility clauses of the 1876 Act are included in that Act so far as the extent of that Act is concerned, and summing up, therefore, it seems to me that under the Public Health Tct as qualified by the 1890 Amendment Act, the law is definite under those Acts, and there is no necessity for the alteration. There certain qualifications are provided: if manufacturers exceed those qualifications there is a way of getting at them by a summons, and they are liable to a penalty and fine. That seems to be the law as it should be.

12933. Do you consider that any safeguards are required to secure that the refuse shall be delivered in such condition and in such regular quantity as not to interfere with the purification of the sewage?—It seems to me that the safeguards provided by the Public Health Act to which I have referred and the Rivers Pollution Act are sufficient, because, as I have already remarked, there are certain conditions provided by those Acts, and anybody who commits a breach of those conditions can be proceeded against in a summary manner by summons, and is liable to heavy penalties. Therefore no further safeguards are necessary.

12934. Could you mention any cases in which a manufacturer has been prevented from doing something that he wishes to do under that law?—Under the Public Health Act?

12935. Yes?—I think in the neighbourhood of Halifax, but there have been none in Halifax, because up to recently Halifax has received the trade effluent. They have received the trade effluent into the sewers and taken the responsibility of it.

12936. But have they taken all the trade effluents in Halifax in the sewers without any preliminary treatment of any sort?—They have taken, I will not say the whole, but the greater part of the trade effluent into the sewers without any preliminary treatment. All the trade effluents, of course, I distinguish between trade effluent and trade refuse in a sense that "trade refuse" appears to manufacturers generally to be rather a misleading term, because trade refuse includes a tremendous lot of stuff that does not go into the sewers, and is taken away by the manufacturer. When it goes into the sewers, first of all there is a grating, and nothing goes into the sewers but that which goes in in solution. There are solids which we include in trade refuse. All those things, such as spent logwood, things of that sort and spent solids in manufacture, are taken and carted away or burned in the boilers, or otherwise dealt with; but what is in solution, what we call trade effluent, goes into the sewers untreated—anything in suspension; whatever does not coagulate, so to speak, in the water would go into the sewers in suspension, and would go through, and that has always been the case. Some of the factories are on the river, as to a portion of their effluent, it would go into the river, but I think pretty nearly all the manufactories on the river go into the sewers as to a great part of their effluent.

12937. Would you contend that anything whatever that will go through the grating is entitled to go into the sewer?—Subject to being treated at a common centre. The opinion of manufacturers is this, that in any district, if it is a manufacturing district, if it is an industrial centre, as these towns in the West Riding of Yorkshire are, the factories contribute such a large proportion of the rates, and contribute so largely to the existence in effect of the district, that the district in providing a sewage system must of necessity provide for a sewage system, including the manufacturing effluent, that the treating of that manufacturing effluent which is recognised by the manufacturers should be, at any rate, at a common centre, by the public authority. They recognise the fact that the treating of the manufacturing effluent must substantially increase the volume of sewage. With regard to that increase, they put it in this way. They say: "Our factories are assessed as factories; they pay and contribute a very substantial proportion towards the sewage system far in excess of any advantage they

gain from domestic sewage, and that such excess must be, if at all, fairly apportioned to the manufacturer, and must go towards any increase of cost which the treatment at one centre is enhanced by the introduction of the manufacturing effluent." And they say that in a great many cases in the West Riding towns it will be found that the factories contribute, even on that basis, more (if it be a question of pounds, shillings, and pence), than their fair proportion if an apportionment were made; but that if in any case it was found, after due inquiry (a local inquiry) into all the circumstances, that the manufacturers did not provide a fair proportion in proportion to the increase of cost, then they quite recognise the fact that it would be fair and reasonable that the factory should be specially rated to meet that excess.

12938. Well, but then would you contend that the manufacturers might put in the whole of their refuse, solid as well as liquid?—No. We, as manufacturers, do not speak of trade refusei n the sense of trade effluent; we speak of trade effluent and we speak of trade refuse, but trade refuse we cart away and we burn under our boilers, we do not put that into the sewers at all. Trade effluents we do put in, and that, as I say, contains in solution what passes, and what passes in suspension, that is any stuff that does not coagulate in the water. If it ceased to be particles it would not go into the sewers, no precipitation having taken place.

12939. Your trade effluent may contain suspended solids and grease, and things like that, which might have a bad effect on the sewers?—Well, now, with regard to that in Halifax, for instance, I think there is no doubt whatever that that has gone into the sewers for as long as man can recollect. The trade of Halifax, of course, has always been very extensive, therefore it is possible to gather from Halifax whether any and what effect detrimental to the sewers has arisen. So far as we are able to ascertain no detrimental effect has ever arisen to the sewers, but, on the other hand, with regard to the towns in Yorkshire, the three towns in particular, Halifax, Huddersfield, and Bradford, which are the main centres of the textile industry, which, of course, would include chiefly where the grease arises, it would appear that the mixture of this special effluent with the sewers has had, from a health point of view, a beneficial effect rather than otherwise. From a table which I have had prepared from the mortality tables, the health tables for the last five years, the effect appears to be very instructive, for I find during the last five years—I have had these tables taken year by year, for five years, and then taken over the whole period to see how they would work out in every way, and I find that in England and Wales the death rate from all causes carried over the five years the average for the five years, 17·7 per 1,000, from zymotic diseases 2·13. Then, if you take the 33 great towns of England, which includes the four Yorkshire towns, the death rate from all causes is 19·3, and from zymotic diseases 2·74. Now, if we take Halifax during the same period, the death rate from all causes is 17·44, against 19·3 for the other great towns. From zymotic diseases 1·56, against 2·13 for the whole of England and Wales, 2·74 for the whole of the 33 towns, and 2·35 for the 67 large towns.

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12940. (*Colonel Harding.*) Do you suggest to us then that the improvement in the health of the people is due to the admixture of trade effluents with domestic sewage?—We do; we say that the effect of the introduction in our districts, at any rate in the textile districts, of the manufacturers' effluent is to neutralise the domestic.

12941. What do you suggest to us as connecting the two?—We suggest as an illustration of the beneficial effect from a health point of view of the mixture of the manufacturing effluent with the domestic sewage that the gases of the sewers are so much weakened generally, and that the effect from a health point of view, suggests that they are not so dangerous in fact, and that there is therefore a beneficial effect from the mixture of the manufacturing effluent with the domestic, both from a flushing point of view and from the general point of view. And there is the fact that what applies to Halifax applies to the three Yorkshire towns where the textile industry is. Now, Huddersfield is very nearly the same as Halifax, and Bradford is a little more. Those three towns, as a fact, have the lowest death rate anywhere in England, so that the system of sewage does not increase or has not tended to any increase in the death rate, and I may say, so far as Halifax is concerned, it is generally admitted and accepted that the lower part of Halifax has the lowest death rate. That is a curious thing, but it always has been so, so that with your permission I will put in the tables for what they are worth:—

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EXTRACT from Registrar General's Mortality Tables, 1897 to 1901, inclusive, showing Annual Death Rates per 1,000 from all causes and from Principal Zymotic Diseases. Towns in Yorkshire in comparison with other parts of England and Wales.

Towns.	Population.	Average Death Rate. All causes. Four Yorkshire Towns.	Average Death Rate. All causes. ——	Average Death Rate. Zymotic Diseases. Four Yorkshire Towns.	Average Death Rate. Zymotic Diseases. ——
1897.					
England and Wales	—	—	17·4	—	2·15
33 great towns	—	—	19·1	—	2·87
Halifax	95,747	16·5	—	1·39	—
Huddersfield	101,454	16·4	—	1·50	—
Bradford	231,260	17·3	—	2·22	—
Leeds	409,472	19·9	—	2·80	—
67 other large towns	—	—	17·2	—	2·41
1898.					
England and Wales	—	—	17·6	—	2·22
33 great towns	—	—	19·0	—	2·85
Halifax	96,729	17·9	—	2·15	—
Huddersfield	102,454	15·9	—	1·61	—
Bradford	233,737	17·6	—	2·12	—
Leeds	416,618	19·2	—	3·12	—
67 other large towns	—	—	17·2	—	2·41
1899.					
England and Wales	—	—	18·3	—	2·21
33 great towns	—	—	20·2	—	2·81
Halifax	97,721	18·3	—	1·50	—
Huddersfield	103,464	16·2	—	1·79	—
Bradford	236,241	18·4	—	2·33	—
Leeds	423,839	19·1	—	2·79	—
67 other large towns	—	—	18·0	—	2·45
1900.					
England and Wales	—	—	18·3	—	2·00
33 great towns	—	—	19·5	—	2·50
Halifax	100,710	[illegible]	—	1·32	—
Huddersfield	104,484	16·8	—	1·52	—
Bradford	291,535	16·4	—	1·36	—
Leeds	431,287	20·0	—	2·92	—
67 other large towns	—	—	18·1	—	2·25
1901.					
England and Wales	—	—	16·9	—	2·05
33 great towns	—	—	18·6	—	2·68
Halifax	105,113	16·38	—	1·42	—
Huddersfield	94,998	16·64	—	1·36	—
Bradford	280,161	16·66	—	1·85	—
Leeds	430,489	19·00	—	3·12	—
67 other large towns	—	—	17·1	—	2·24
1897 to 1901 (Five Years).					
England and Wales	—	—	17·7	—	2·13
33 great towns	—	—	19·3	—	2·74
*Halifax	—	17·44	—	1·56	—
*Huddersfield	—	16·39	—	1·56	—
*Bradford	—	17·27	—	1·98	—
†Leeds	—	19·44	—	2·95	—
67 other large towns	—	—	17·5	—	2·35

The Industries are :

* Chiefly woollen textile industries.

† A variety of industries, namely, textile, tanning, galvanising and others.

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Well, then, with regard to the treatment at one centre we say that the cost of the treatment at one centre is very much less in proportion than the cost would be if parcelled out to each of the factories, were that possible, but in the West Riding towns, and speaking of Halifax, and what applies to Halifax applies to the other towns, the factories in those cases are so confined that they have no space whatever to provide treatment. They are surrounded by houses up to their very walls, and they would find a very great difficulty in providing means for the necessary treatment at their own works, besides the extra cost parcelled over each factory would far more than exceed anything which they would contribute to one centre, and they say it could not be so well done.

12942. (*Chairman.*) But you are prepared to admit that the manufacturers ought to adopt some means for removing solids?—Yes, solid refuse; that we say we always have done.

12943. (*Sir William Ramsay.*) The solids from effluents, I think?—The question rather is——

12944. Suspended solids it is called?—Solids in suspension. If they were solids (I do not know the right term, but I say) which coagulate in the water, they should be removed, that they, we take it, would be removed as matter of course; that, except as above, if there were solids in suspension that they should go, and they would be taken out in the common centre.

12945. (*Major-General Carey.*) Are not the solids in suspension removed at present?—I think you will find that the majority is, the majority of those solids are removed at present.

12946. In what way?—(*Mr. Crossley.*) I do not think they are taken out. (*Mr. Smith.*) Only the very dense solids. (*Mr. Marshall.*) You may call it dense solids. (*Mr. Crossley.*) Wool washing and sand. (*Mr. Marshall.*) There is generally a small catch pit or something of that kind where it goes into before it goes into the sewer, I am told. (*Mr. Crossley.*) No refuse from manufacture is put into the sewer at all, not in the ordinary meaning of the term "refuse"; there is nothing in the shape of offal and that sort of thing.

12947. (*Sir William Ramsay.*) We do not trouble much about that, but the difficulty arises in turning in substances which contain soapsuds, for example, or dye waters, or scouring water, water full of grease. These let down large quantities of solids, which are very difficult to get rid of indeed in the general treatment?—(*Mr. Crossley.*) Well, the bulk of dye water I do not think contains a very serious amount of solid.

12948. The water from wool washing does?—Wool washing, but I think in many cases there are catch pits in our works where we catch it before it goes into the sewer.

12949. Indigo dye?—A very little indigo should go into the sewers.

12950. (*Colonel Harding.*) Should go?—And very little does go. He is a very bad dyer indeed who allows indigo to go into the sewers.

12951. (*Major-General Carey.*) Do you consider a catch pit is sufficient to intercept the grease from an effluent?—I do not think it would catch all of it, but it would be a very considerable help. There is a great amount taken out of our catch pits I know. Sand from Persian wools, and wools which are very heavy with lime and sand, a great deal comes out in these pits. (*Mr. Marshall.*) Then there was one other case to which I would call attention. In speaking of Halifax (I have no doubt it applies to other towns as well, who have accepted as they have done in Yorkshire, particularly the large towns, the manufacturing effluent), as a result of such facilities having been given, factories have been erected on the strength of those facilities, and corporations have connected the sewers up to the site of proposed factories as an inducement to erect the factories. Those factories have been erected, and are surrounded with buildings in every possible way; they have no other outlet whatever but the sewers, as previously constructed, so that those are cases in which of course a difficulty must arise under any circumstances.

12952. (*Chairman.*) Are you of opinion that there should be some tribunal such as, for example, a Central Government Rivers Board, to whom an appeal could be made when a local authority refused to allow trade effluents to go into the sewers?—The opinion of the manufacturers of the Halifax district is, that these questions can best be dealt with by the ordinary courts of justice.

12953. What are the difficulties the manufacturers usually meet with in dealing with local authorities, and what are the reasons generally advanced by local authorities for refusing to allow trade refuse to go into the sewers?—Well, of course, in the case of Halifax they have not had any difficulties until recently. Recently within a short period I think the Rivers Board have brought some pressure on Halifax to construct sewage works, and the Local Government Board and Halifax have proceeded with the construction of their sewage works, and I take it they have based the construction and the cost of the sewage works upon the quantum of effluent which has been accustomed to come down the sewers. And these sewage works, so far as the tanks are concerned, are approaching completion, but they have not put the sewage works into operation yet, so far as the land is concerned.

12954. (*Sir William Ramsay.*) What treatment is suggested?—I think it is a bacterial process plus land filtration. There were several experiments made in Halifax some years ago in regard to that, and it was found to be most successful so far as Halifax sewage is concerned.

12955. And up till now the Halifax sewage simply runs into the river without precipitation?—They have had a system of settling tanks, but not sufficient, and under the present system I think they have increased the settling tanks some 200 or 300 per cent. in capacity—more than that.

12956. (*Colonel Harding.*) For the purpose of transforming them into septic tanks?—No doubt, and no doubt based on the volume of sewage which has already come down, which has included manufacturers' effluent.

12957. (*Mr. Stafford.*) But is it only since then that there have been difficulties with the local authority?—It is only since then, for the last few months that there have been. They are framing some regulations which have been submitted to the manufacturers, but which they do not consider are practicable so far as Halifax is concerned, and with regard to those I think it is admitted by the Town Clerk of Halifax as well as by ourselves that they are not in accordance with the present law, and that they were not legally enforcible. I think that has arisen by pressure from the Rivers Board that Halifax should treat their effluent. What the effect of that treatment may be when the sewage works are completed, and the land which they have acquired brought into operation, of course we cannot say, but I know in 1895, when the experiments were being made with regard to the treatment which has been adopted, this oxygen process, I for the manufacturers, went to the works and took a sample, or the manager took a sample with me (as a matter of fact, not with regard to the Halifax sewage, but it was in regard then in connection with a large factory in which difficulties had arisen as to riparian rights), to see if this would be practicable to use in connection with them. I took this sample from the effluent after it had left the septic tanks and was flowing into the river. It happens to have been in my office ever since, and for what it worth you could see the effect of the treatment of the Halifax sewage then. I see my note is, "Sample of sewage water taken from Halifax sewage works at Salterhebble after treatment by the oxygen sewage process, 17/10/95." That included manufacturing effluent and the domestic sewage, and there it is. There is nothing in it so far as I have been able to ascertain but a little vegetable matter. It is perfectly neutral. I have had it tested for acid, and, while I am on that point, I think I might bring to your notice this fact, with regard to the Hebble brook that flows through Halifax, and with regard to the proportion of the effluent which goes into the brook from the various manufactories, which include acids from, I think, a wire works, and the mixture of all these things makes the water perfectly neutral. Down and at the bottom of the stream they are able to use it for the boilers, because it has become neutral by the various alkalies and is antiseptic.

12958. (*Chairman.*) Would you tell us exactly the present position of Halifax between your committee and the local authorities?—The position at present is this: The regulations were considered by the manufacturers, and, as I said, they did not consider them practicable, neither did they consider they were in accordance with

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the existing law; and, so far as they were concerned, they did not see it was possible to adopt them; and they suggested to the corporation that if some scheme could be formulated for dealing with the whole of the effluent at a common centre (something on the principle that I have suggested); and if it were found that the factories were not paying their proper proportion of any extra cost, that they would be perfectly willing to deal with a special rate as to any excess.

12959. Is that proposal of the traders now under the consideration of the corporation?—The corporation did not consider the proposal in that sense. I think they have stuck to their regulations, and I see by the paper this morning that these regulations are approved by the corporation last night. (*Mr. Crossley.*) They were passed by the general body of the council.

12960. (*Colonel Harding.*) By "regulations" do you mean "conditions" antecedent to the reception of the effluent into the sewer?—(*Mr. Marshall.*) Yes, certain conditions which have been suggested by the corporation, and which I think it is mutually admitted cannot be enforced.

12961. Meanwhile they are confirming them?—They have confirmed them as, no doubt, being desirable from their point of view.

12962. (*Chairman.*) Then at this present minute all your trade effluent goes into the sewers?—Yes. (*Mr. Crossley.*) No. (*Mr. Marshall.*) The greater part. (*Mr. Crossley.*) Do you mean from manufacturers in general. I suppose the greater part does, but by no means all. (*Mr. Marshall.*) A considerable proportion will go down the river, too, with regard to those factories on the river, but the greater part of the manufacturing effluent of Halifax goes into the sewer, and even from those factories on the river the greater part will go into the sewers.

12963. But it goes into the sewers without any preliminary treatment, but the solids are usually removed by means of catching pits?—Of catching pits. (*Mr. Smith.*) Precisely, that is the general rule.

12964. But, excepting they remove what you call dense solids, there is no treatment at all?—(*Mr. Marshall.*) No.

12965. And you contend with the bye-law you can send it into the sewer in that way?—Yes, and we suggest that is a desirable thing in order to get over the difficulty of treatment before it goes into the river, that it should be treated after the dense solids have been taken out, that it should be treated at a common centre, and that everybody should contribute to it, if they do not already have any excess treatment.

12966. (*Colonel Harding.*) The members of your association for the most part are already connected with the sewers in Halifax?—That is so.

12967. Such as Crossley's for instance?—(*Mr. Crossley.*) We are connected with the sewers up to a certain extent; we do not put anything like the whole of our effluent down the sewers.

12968. But you have connection?—Oh, certainly we have connection.

12969. And you?—(*Mr. Baldwin.*) In 1871, when our new mill was erected we were connected by the corporation to their sewer, and ever since part of our effluent has passed into the sewer, and the rest of our effluent goes into the stream.

12970. And which is the mill belonging to the Woolcombers' Association, which is represented by its Director?—(*Mr. Smith.*) Kensington Works; still it is in the Borough of Halifax.

12971. That is also connected with the sewers?—Entirely, sir.

12972. The difficulty in connection with the condition of the law and the responsibilities of the local authorities seems to me to arise rather with mills applying for connection to the sewers, than with mills already so connected and claiming a prescriptive right; is not that so?—(*Mr. Crossley.*) I do not think the corporation will admit a prescriptive right.

12973. Well, but as a fact many of you are already connected?—(*Mr. Marshall.*) Yes. (*Mr. Crossley.*) Certainly.

12974. That is a fact, is it not?—(*Mr. Marshall.*) Yes.

12975. And you, in your answers, suggest that the condition of the law is quite clear, and that you see no necessity for altering it, because your position is evidently a very strong one; you are connected already?—(*Mr. Baldwin.*) Certainly.

12976. But where a manufacturer applies to the Corporation of Halifax for permission to connect with the sewer, his case is not so easy. Is it because the corporation then says: "Well, we will receive your effluent upon certain conditions," which they proceed to state, which they recently confirmed, as you have told us just now. Well, in that case, is the law sufficiently clear to permit that manufacturer to say to the Halifax Corporation: "You must receive my effluent"?—(*Mr. Crossley.*) We shall have to make an application ourselves personally shortly for a further connection, and I am quite satisfied with the existing state of the law.

12977. But are you aware that, as a fact, applications have been made all over the West Riding to local authorities, and have been refused, and that so far manufacturers have not been able to compel local authorities to take their effluents except on submission to certain conditions?—But have they carried their case to extremes, or has it been done with gentle pressure?

12978. I do not think the pressure has been very strong any way, because the manufacturers have not been generally anxious to do anything at all?—(*Mr. Marshall.*) I will point out this that in several cases in the West Riding the objection raised is: "Oh, but we have no accommodation in our sewers; they are not large enough; we cannot take it, because the sewers have never been constructed to take it." But in the large towns that does not apply. They have been constructed and have been taking it, and therefore the Public Health Act comes into force at once, which does not create any limit under Section 21. Subject as in Section 21 you are entitled to have a connection with the sewer.

12979. But you yourself grant, will you not, that the authorities are able, under the Public Health Act, and the Rivers Pollution Act, to claim either that their sewer is not large enough, or that the effluent will prejudice the treatment of the sewage, and that upon those grounds they, in fact, do often refuse to allow connections?—Oh! undoubtedly, in smaller districts where their sewers have never been constructed to take the effluent, that must be so; but in those cases I would point out that is very generally in country districts where the difficulty is not so appreciable as it is in towns.

12980. Then we gather from your evidence that your association is of opinion that it is to the advantage of the trade of a district that the local authority should give facilities for connection with sewers?—We think so. (*Mr. Crossley.*) Undoubtedly.

12981. And you probably think that the wholesale treatment of the trade effluents at some central place by the local authority is more likely to be effectively carried out than the separate treatment at the various manufactories?—Certainly, and more economically too.

12982. But, on the other hand, does it not appear to you also reasonable that before allowing connection with the sewers the authority should lay down certain conditions in regard to preliminary treatment by the manufacturer; not, I mean, to the extent absolutely of purifying the effluent so as to make it fit to go direct into a river, but to the extent of settling out suspended solids, grease, neutralising acid or alkalinity, and so forth?—(*Mr. Smith.*) I do not think there is a dispute in Bradford, although, of course, the bulk of our manufactories are in connection with the Yorkshire wool trade. The whole of the association is at present situate in Bradford or nearly so; there is only our firm in Halifax. Some of the firms do precipitate, and some do not. To us it seems most undesirable to precipitate fats at all locally; that ought to be done at one centre. It seems to be the best way unquestionably for precipitation. Take, for instance, alumina ferric, it forms a most abominable precipitate, and would make big nuisances all through the town; there is no getting rid of it at any price in any way if it is locally produced.

12893. You are referring to the chemical precipitant?—To the chemical precipitant alumina ferric, which is used in many places where they adopt precipitation.

12984. What I want to get at is this: The Commission, of course, are taking evidence for the purpose

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of ascertaining the opinions both of local authorities and manufacturers in regard to this difficult question, and local authorities called our attention to this fact, that in many cases—in most cases—the reception of trade effluent into their sewers either prejudiced the treatment, or, at all events, makes the treatment much more difficult. We asked several also in regard to the presence of suspended solids, and in many cases authorities have told us that, recognising the necessity of promoting or assisting trade in their districts, they have expressed their willingness to receive trade effluents, provided the manufacturers will carry out certain reasonable preliminary works for the settlement of solids and the removal of grease, and so forth.

(*Major-General Carey.*) And the regularity of the flow.

12984*. (*Colonel Harding.*) And providing regularity of the flow, and apparently with general satisfaction to the manufacturers. The manufacturers found that carrying out such works is a very much lighter business and less expensive business for them than satisfying the Rivers Board, and turning their effluent into a stream. If he is merely asked to settle his solids he may send down impurities in solution into the sewers, and the cost will be much less then being called upon by a Rivers Board to purify his effluent thoroughly to permit of its going into a stream. What I should like to know is whether your association does not think that it is reasonable for the local authority to lay down certain conditions of that reasonable character?—(*Mr. Crossley.*) There will be so many exceptions I am afraid that will have to be made to those conditions. Owing to the formation of the land in Halifax it is an extremely narrow valley, and those mills are situated in the middle of the town, where there is absolutely no land at all; it would be almost an impossibility to get any place at all where they could precipitate solids. In our own case we are in an extremely narrow valley; we have from 750,000 to 1,000,000 gallons which we would have to treat, which would mean an acre of land a yard deep; and if you are going to make exceptions, supposing we could prove such a strong case that we really could not precipitate, and get rid of our solids well, then naturally other manufacturers say: "Well, these people do not, why should we?" You can hardly make one law for one man and one for another simply because one man has not space.

12985. Your position of being already connected with the sewers is a fairly strong one, and different from that of those who want to make a new connection with the sewer, and there it would seem the local authority is justified by the condition of the law in insisting upon certain preliminary treatment?—But these conditions of the corporation are supposed to be retrospective, I take it.

12986. Their intention is to make them apply to those who are already connected?—I think so.

12987. You claim to be exempt because you are already connected; is that it?—Well, I think there will be a great amount of difficulty. I think it is quite likely they will say to us: "We shall not take this effluent." We do not know what they are going to do, of course, but it is quite likely they may do that.

12988. But the settlement of solids, say in your own works, would not be so serious a matter either in regard to the land required or the expense?—It would indeed.

12989. What is your total flow per 24 hours?—It is difficult to estimate; certainly close on 1,000,000 gallons.

12990. Per day?—Yes.

12991. Have you not room for a settling tank with a capacity of 1,000,000 gallons?—Well, I understand to settle that will require an acre of land a yard deep; that is for about 800,000 gallons per day, and how should we be able to send down that quantity of water at a constant flow.

12992. It is not necessary to send it down at a constant flow?—We have no land, excepting by pumping an enormous distance. The configuration of the valleys in Halifax will not allow of it, and Messrs. Baldwin are in exactly the same position. (*Mr. Baldwin.*) We have the use of the sewers in the upper portion of our property. The stream falls rapidly. In the lower portion of our property we have no outlet into the sewer, and the trade effluent there runs into the stream. The West Riding Rivers Board know we cannot do anything. It is a road mainly adjoining our property there, we have got no liberty there to place tanks.

12993. And have you no room for settlement?—We have no room whatever for settlement below, because in our case we should have to make tanks to hold it before we could pump. Supposing we could do that, and to make the manufacturer lift all his trade effluent back again up to some higher land to enter the sewer there would be an excessive hardship. We have not the land. Of course, if we had to put in a receptacle to hold ours it would have to be put in the stream, because there is a road actually bounds us on the lower side of the valley, so that it would be perfectly impossible for us to do anything; and we are surrounded on the other side.

12994. In the case of new applications to the corporation to connect up with the sewers do you or do you not think it reasonable for them to make conditions before they receive the new effluent?—I consider that the mixture of the different effluents would neutralise this because in my own works at the present time we are using the beck water for our boilers. Our boilers are made of iron, so if the river water were strongly acid the destruction of our boilers would be very rapid. We have boilers there which have been working for 15 years, and they are still at the full insurance—70lbs. pressure. We put them in 15 years ago, and they are still allowed, and we are using them at the works. (*Mr. Crossley.*) That passes through our works? (*Mr. Baldwin.*) Yes, that passes through your works, and trade effluent passes into this beck, which they consider is injurious to their sewers. That water we are using for our boilers, we have used for many years, and our boilers are in such a condition that the insurance company still takes them at their full insurance.

12995. You claim that the reception of various effluents into a sewer causes a neutralisation, and does away with the difficulties which might attend a specific effluent, which might be alkaline or acid?—The result at the trade outfall works I consider that effluent must be practically neutral.

12996. But I understand the local authority at Halifax recognise that, and are not unwilling to receive trade effluents with certain conditions, and the conditions that they make simply apply to the removal of suspended solids, of grease, and the regular flow. That was what they told us. Does that or does it not appear to you reasonable in case of new applications?—I consider as regards regular flow it can be easily done at the outfall works; because they could have storage tanks there to store it. But they must have to deal with variable quantities. When it is fine weather, there cannot be so much sewage coming down as when there is a thunderstorm, and a very large flow. How would they deal with such a case as that?

12997. In many towns regulations have been made about a regular flow with very great advantage. For instance, in cases where a vat is let off by pulling up a plug, and a large quantity of acid matter is sent up into the sewer it may cause very serious difficulty, both in the sewer and in connection with the treatment of the sewage; whereas if that was allowed to flow gently out of a storage tank at an equable rate throughout the 24 hours, its presence would scarcely be noticed?—But I should consider the working hours are much the same time. We are restricted by law to work only such and such hours, and it would be customary for all mills to let off their effluent at much the same time.

12998. But if it were stored—let off at the same time, and stored in the separate works, and then it flowed through a certain sized pipe regularly throughout the twenty-four hours, the regular flow would be maintained, which would permit of something like equable conditions at the sewage works?—(*Mr. Crossley.*) It would be absolutely impossible for us. We could not store one million gallons of water and let it off in regular quantities. (*Mr. Smith.*) We have much less quantity than that, and we could not do it. In the town, at some of the mills, there is no room whatever; practically all around are dwelling houses—many of them are so.

12999. We appreciate that. In those cases where no objections have been made to the reception of the effluent into the sewers, you have occupied your land by buildings, and, at the present moment, in view of this having been permitted in the past, there are special

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difficulties in carrying out the requirements for these works; but in the case of new applications, surely the making of conditions by the authorities is quite a different thing?—(*Mr. Baldwin.*) That is a little unfair, is it not, towards an older business? It is an advantage sometimes to have an older business, but it seems unfair upon a new comer that he should be handicapped, and have to do these things, while somebody else in the same trade, probably because he has been longer, has those privileges allowed him.

13000. It is unfortunate. No doubt, it is very fortunate for you gentlemen who are already so connected?—Yes; we have been in business 117 years in the same place, and we are, of course, completely shut in. The West Riding Rivers Board come to us—they have come to us scores of times—and I have been round with the inspector and showed him where we were—and it is an impossibility.

13001. The point is this: that the legal aspect of the question will have to be fought out. New conditions have arisen for your local authority; in the old times they were allowed to turn their sewage into the river without any treatment at all; now new conditions have come about, and they are compelled to treat it, and to treat it effectually. These new conditions will, no doubt, affect these old factories; they will have to be fought out, no doubt?—We want to save money where we can; we do not want to waste money unnecessarily, and, of course, one can quite see that the combination in effect is an advantage; and, surely, if the town is there for the trade of the district—in fact, of course, the trade of the district really supports the whole town—therefore, the cheapness of a concentratedness of treatment at one centre is surely advisable.

13002. I think that is quite agreed to by your corporation; but what they say, and probably say with great truth, is that the presence of suspended solids to any large extent in a trade effluent increases enormously their difficulty in dealing with their sewage, because, as you know quite well, dissolved impurities are easily dealt with, suspended impurities are much less easily dealt with, and, again, the presence of grease is a serious difficulty; and, if the manufacturers in Halifax, who have been already connected, would recognise these difficulties of their corporation, and assist them to the extent of removing the grease, as far as possible, removing the solids, as far as is practicable in these old works, it would facilitate the work of the corporation very much, and, no doubt, increase their readiness to assist other manufacturers who ask to be connected?—(*Mr. Smith.*) It is a great question, and the corporation will have an opportunity of proving it, perhaps, presently; whether there is not a very great deal more grease and a great deal more solids sent down by domestic sewage than there is from all manufacturers' solids. It is also a very great question indeed, if there is not more soap used for domestic purposes (I am certain, in Halifax, very considerably) than there is for manufacturing purposes, and, if the fats are the difficulty, they have got to deal with, they have got them to deal with there already.

13003. Then, we are to take it, as the result of your evidence, that you gentlemen, representing many manufacturers in Halifax, who are already connected with the sewers, decline absolutely to assist the corporation by carrying out any provisional works whatever?—(*Mr. Crossley.*) We think it would be far better done by the corporation. (*Mr. Marshall.*) And we should be prepared to contribute to the cost. (*Mr. Crossley.*) Certainly. (*Mr. Marshall.*) The cost of centralisation. (*Mr. Crossley.*) We are only looking after our own pockets. We should have to pay the corporation. We prefer to pay the corporation for it, they could do it cheaper than by private manufacturers.

13004. (*Major-General Carey.*) Supposing the corporation say it is not possible; the area they have in Halifax for sewage disposal works is limited?—The land?

13005. Yes, the land?—I do not know.

13006. Oh, yes, it is very limited?—(*Mr. Marshall.*) There is a considerable amount of land, but I think it is limited for the area of population.

13007. Depending upon settling tanks and bacterial filters, they have taken as much land as they possibly can, but that land is extremely limited in area. Supposing they say: "Well, whatever our willingness may be to take your effluent, we cannot take it without preliminary treatment of some kind?—(*Mr. Baldwin.*) What they have got now, they have taken from a district council; they could go further on the left hand side of the road, where they have got it for their land filtration; they could get a large quantity more there, but they would have to pay for it.

13008. (*Colonel Harding.*) The evidence from other towns has been clearly that in most cases manufacturers have recognised the duty imposed upon them of carrying out such reasonable preliminary treatment as the local authority require, and in a great many cases that has been done with mutual advantage, because then most manufacturers have been able to connect with the sewers. If no assistance is given by the manufacturers, the difficulties of the local authority may be so great that they will not try to do it?—In that case, must the manufacturer buy the land near, and conduct his effluent to the nearest land he can buy, whatever exorbitant price they wish to name for the land.

13009. I am afraid that is not a question we are prepared to answer?—(*Mr. Marshall.*) That is rather too big an order. The question, of course, in every case would be whether or not it would be reasonably practicable. That would be so, I take it.

13010. We have a good deal of evidence of manufacturers, who, at considerable cost, have carried out satisfactory works, and have told us their business has not been ruined by that outlay?—There is no doubt that in the outlying districts, where there is plenty of land, there is no difficulty. (*Mr. Crossley.*) No objection at all. (*Mr. Marshall.*) The difficulty is not felt by the manufacturer. Of course, the difficulty is in the towns where we are so limited in space, that is where the whole difficulty arises. In outlying districts the difficulty really does not arise, because you can get the land without any difficulty, but in Messrs. Crossley's case and Messrs. Baldwin's, there is no land anywhere near, and the lie of the land behind; anything nearly approaching open land is a hillside behind them that has a fall of about one in two, in fact, it is impossible to walk up it. That hill goes up 800 feet. It would be impossible to put any tank cistern to hold their effluent in that place at all. But it must apply, not only to Halifax, but all the towns, and I have no doubt you gentlemen will have plenty of evidence to that effect that the great difficulty is in the towns of dealing with it. (*Mr. Crossley.*) Particularly in such places as Halifax and Huddersfield and Bradford. Of course, in these Lancashire towns, Rochdale, Oldham, and all over, they have got a flat level land to deal with; they have not got shaly hill side, where the cost of foundations alone would be enormous.

13011. (*Colonel Harding.*) In your case, Mr. Baldwin, I think you said some of your effluent went into the river?—(*Mr. Baldwin.*) Yes, it does.

13012. Is any pressure put upon you by the Local Rivers' Board?—We have had numerous visits.

13013. Are you doing anything?—It is impossible. I have been round several times with the inspector, and I showed him we had not got a square inch of ground where we can put anything to deal with it, so as to give a good result, and it has gone into the river since the mills were put there. In our position they said: "Well, we cannot see anything; the corporation must deal with you." That is how things stood at the last visit. I do not see how we can, because our works are down by the stream, and the dye house is the lower portion of our property.

13014. You would have to pump to get into the sewer?—No, we could get into the sewer, but we could only get into the sewer with a direct pipe; we should have no means of making a storage tank to hold the amount of half a day's flow. We should have really, so far as I can see at the moment, no possibility of making such a tank, not without expense. Would have to get permission of the corporation to make it in the roadway.

13015. Are we to take it that in the special circumstances in which many a man is placed, not having land to carry out any preliminary treatment whatever, you are willing to contribute towards the extra cost which the local authority would be put to in dealing with those effluents?—(*Mr. Crossley.*) Provided they can say we are not paying our proper proportion now. (*Mr. Smith.*) We pay a heavy proportion now.

13016. Ironworks, which turn out no effluent at all, then might be rated at the same rate as your works, Mr. Baldwin, would pay exactly the same as you would, and would not cause any trouble or expense to the local authority?—(*Mr. Marshall.*) That would be a basis of fixing the special rate, that would be a basis

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of dealing with it, a matter of detail as to what proportion the various trades should contribute. For instance, in these towns, the trade, as a rule, of any dimensions, would be under certain heads; for instance, the textile trades should contribute so much on their assessment, and so and so trades so much on their assessment. That would be a matter of detail. On the inquiry as to the fixing the settlement of a special rate, where it was found that the proportion already contributed by the business proprietors was not practically more, as they do in many cases, I am told, pay more than their proportion of the extra quantity. In other words, to make myself clear, if there was a domestic sewage rate, pure and simple, confined and levied upon the domestic properties, and a manufacturing system, limited to the manufacturers, the manufacturers have more than paid towards their's, whereas the domestic effluent would be very much under-paid, than by the joining up in many cases it would be found. (*Mr. Smith.*) There is just one illustration of the unreasonableness that we sometimes find, and that we should find now if the corporation were allowed to have its way in relation to the manufacturers' effluent. Section A, under No. 2 of their rules, which they seek to enforce, states that the effluent must be free from solids in suspension beyond 15 grains to the gallon. Our chemist tells me that it is not possible, by any means of filtration, to reduce it to less than 150 grains, that is 10 times the quantity that is here put as a limit.

13017. (*Sir William Ramsay.*) From your effluent? From any manufacturer's effluent in the textile industries; so that that would be setting an absolute impossibility for a start; we could not do it.

13018. (*Major-General Carey.*) You say that ought to be done by the corporation themselves?—Quite so, yes; yes, certainly, by their precipitation tanks. (*Mr. Marshall.*) I think it is perhaps justice to say that they have recognised the impossibility of doing it themselves, and they have eliminated that particular question from the rules. (*Mr. Smith.*) Have they taken that away? (*Mr. Marshall.*) They have eliminated that particular condition from them; they have found it was absolutely impracticable.

13019. (*Colonel Harding.*) I should just like to go back to something you said in your earlier evidence, that you thought the condition of the law was perfectly clear, that under Section 21 of the Public Health Act, the owner or occupier of any premises within the district of the local authority could claim connection with the sewer?—Yes.

13020. And you stated that certain cases had been before the courts, and had been settled in favour of your view. Can you give us any specific instances where a person so claiming has obtained, legally, connection with the sewer?—I can give you these cases where the corporation, in the Ainley case, for instance, the plaintiffs were millowners, with premises in the district of the local board. They connected with a drain with defendant's sewer, which was formerly an open watercourse, and then emptied into a stream. Proceedings were afterwards taken against the local board to restrain them from fouling the stream, and then the board gave notice to the manufacturers, under Section 21, of their intention to go in the drain.

13021. But the connection had already taken place?—Oh, in all those cases the connection has taken place.

13022. Then you do not know of any specific case where application has been made for a new connection, and where that application has been maintained against the local authority, if the local authority claimed that the effluent prejudiced the treatment?—Oh! no, I do not. I may say that on those lines the manufacturers have been advised by eminent counsel, Mr. Macmorran, who is an eminent authority upon these matters, that they are so entitled, and to maintain their right to go in as ordinary ratepayers under that Section 21, that those conditions—there are certain regulations under Section 21—that those regulations must be made applicable to the whole sewage of the area, and subject to that they can go.

13023. Do you happen to know whether the local authority has been advised by eminent counsel, too?—I am only stating those points which will no doubt have to be contested when they come, only in a great many cases you will probably be aware that small manufacturers, where they are taken, they will do anything for peace.

13024. I just refer to this because your evidence is that the condition of the law is quite satisfactory?—Yes, in all these cases it has been in favour of the manufacturers. With regard to the latter points, and the riparian rights, you have not asked any questions about those.

13025. (*Chairman.*) What would be the effect upon the flow of the water in the stream in the case in which the manufacturer uses the water from the stream in his manufactory if the trade refuse were delivered into the public sewers?—Of course, the answer with regard to that is that the manufacturers must of necessity limit the discharge into the sewer to the quantity of water he obtains from other sources, such as the town, or the wells and springs, and the river. Naturally, the flow of the river must be kept up, and that is, I think, generally speaking, done, practically.

13026. In such cases is any alteration in the law desirable so as to get over the difficulty of riparian rights?—I think the opinion, generally, of the manufacturers is no. It would be such a difficulty, the present system works; it is very seldom that a man oversteps the reasonable boundary, and if he does not, then they work together.

13027. (*Sir William Ramsay.*) Only one question before you go. Have you any idea as to the relative amount of the rates paid by the manufacturers in Halifax and those paid by the general population; an approximate guess even would be of interest?—I think the amount paid by the factories would very nearly approach one half. I am speaking roughly. I think the amount on the factories and premises in connection with the factories would very nearly be about one half.

13028. That, of course, does not include the rates that the operatives pay from their own dwellings?—The operatives rates are paid by the owner; the operative himself, as a rule, gets his cottage rates free, and they are paid by the owner of the property. I think it is under £20 a year, something like that, that falls upon the owner.

FORTY-FOURTH DAY.

CITY HALL, DUBLIN.

Monday, 28th July 1902.

PRESENT:

Sir WM. RAMSAY, K.C.B., F.R.S. (*Chairman*).

Colonel T. W. HARDING.
Mr. J. BURN RUSSELL, M.D.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary*.

ALSO PRESENT:

Dr. A. C. HOUSTON.
Mr. COLIN C. FRYE.

Sir C. A. Cameron, M.D.

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Sir CHARLES A. CAMERON, M.D., called; and Examined.

13029. (*Chairman.*) You are Public Officer of Health in the City of Dublin, and Professor of Hygiene, Royal College of Surgeons?—Yes.

13030. I believe you hand in the results of certain analyses of sewage taken in different parts of the city?—Yes.

13031. Are these average analyses, or are they special individual analyses?—They are taken from eight different parts of the city, so as to get as far as possible a pretty equable specimen of the ordinary sewage.

13032. What I mean is, are they averages?—No, they are single determinations.

13033. Are they regarded as anything abnormal?—No, I think they are very ordinary kinds of sewage. We have not many manufactories, especially dye works, in the city—in fact, only one or two—and therefore there is not much exceptional material like dry earths going into the sewers; there is a little, but it forms a very, very small proportion of the total.

13034. Would you be inclined to make an exception in the case of the breweries?—No, I would not, having regard to the immense quantity of sewage with which the sewage from the breweries becomes amalgamated. You have the analyses of the sewage from one of the city breweries in that table which I hand in, No. 7. I may say that two breweries contribute nearly all the sewage which can be properly described as brewery drainage. Generally speaking, all the sewage had a strong odour of sulphuretted hydrogen, with two exceptions. In one of these cases it was not very strong, and in the other there was almost no odour, and that was where the sewage came from the brewery. That refers to No. 7 in the table, and in that case there was only 3·30 grains of suspended matter per gallon, and only 2 grains of cellulose per gallon and traces of starch. The worst sewage come from the sewer into which that brewery discharges—the street sewer in Rainsford Street—that you will find in No. 8. The sewage there contained over 141 grains of solids per gallon, and it took 10·84 grains of oxygen to the gallon, which is about double the quantity in the other drainages. Although in one case there was a larger amount of solids—namely, 144 in the Watling Street sewer (No. 2), and 3·5 grains of cellulose and 3 grains of starch. There was another exceptional sewage (No. 8), which contained 5 grains of oxide of iron per gallon, and there was one other sewage which differed considerably from the general run of the samples. It contained 48·70 grains of chloride per gallon, or nearly half of the total solids; the solids were 144·80 and the chlorine 48·70, but on making inquiries I ultimately came to the conclusion that that was due to the enormous gut factories in that district. It appears the practice is, when the intestines are taken out they are packed in immense quantities of salt, so that I think the chlorine is contributed by the gut factories—of course it will as common salt, so that practically the 48 grains would run to between 70 and 80 per cent. of common salt. These are the only exceptions in the samples. (*Witness then handed in the following table*):—

COMPOSITION of DUBLIN SEWAGE, taken July 1902.—A Gallon of each contains in Grains—

—	Smithfield. 1.	Watling Street. 2.	Fitzwilliam Street. 3.	Cardiffs Lane. 4.	Seville Place. 5.	Drumcondra. 6.	Rainsford Street. Brewery Discharge 7.	Rainsford Street. Street Sewer. 8.
Suspended matter	35·28	12·08	17·92	15·12	40·04	25·76	3·30	36·80
Solids in solution	40·88	132·72	46·48	162·24	63·28	33·60	—	104·36
Total solids	76·16	144·80	64·40	177·36	103·32	59·36	59·60	141·36
Organic and volatile matters in suspended matter.	18·00	2·80	3·68	6·72	7·15	17·20	—	16·20
Fixed mineral substances	17·28	9·28	14·24	8·80	32·89	8·56	—	16·60
Organic and volatile substances in soluble solids.	12·88	32·48	19·68	29·68	7·28	13·44	20·00	28·36
Fixed mineral matter in soluble solids.	28·00	100·24	26·80	132·16	56·00	20·16	36·30	90·40
Chlorine	5·96	48·70	10·48	18·39	19·38	6·96	1·50	1·59
Nitrates	Traces.	Traces.	Traces.	Traces.	Traces.	Traces.	Traces.	Traces.
Albuminoid ammonia	3·57	1·78	2·10	3·50	3·50	6·10	0·40	1·50
Saline ammonia	0·25	6·15	1·20	1·40	1·75	1·40	0·17	0·25
Oxygen absorbed in moist combustion.	5·43	5·24	5·63	4·75	6·05	5·78	5·48	10·84

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OBSERVATIONS.

No. 1, Smithfield Street.—Sewer at Haymarket.—Odour of sulphuretted hydrogen.

No. 2, Watling Street.—Sewer at Coke Lane.—Odour of sulphuretted hydrogen: not much suspended matter. One-third of the solid matter is chlorine. This chlorine as sodium chloride is probably derived from the gut factories in the neighbourhood, as the intestines of animals in these factories are liberally treated with salt. The suspended matter included 3·5 grains of cellulose and distinct traces of starch.

No. 3, Fitzwilliam Street.—Sewer at Baggot Street.—Odour of sulphuretted hydrogen.

No 4 Sewer at junction of Cardiffs Lane and Misery Hill.—Odour of sulphuretted hydrogen. A very large amount of solid matters. Traces of hydrocarbons present.

No. 5, Sewer at Seville Place, opposite Cobourg Place.—Odour of sulphuretted hydrogen. Much suspended matter.

No. 6, Drumcondra Tanks.—Slight odour of sulphuretted hydrogen. Total solids not large in amount.

No. 7, Rainsford Street.—Syphon pipe, discharge from brewery. Almost no odour. Nearly clear, yellow colour. Very few large suspended particles. It contained 2 grains of cellulose per gallon and traces of starch.

No. 8, Rainsford Street Sewer.—Very dark-coloured. Numerous large particles. Much suspended matter. Very bad odour of sulphuretted hydrogen. Contained 5 grains of oxide of iron.

13035. (*Chairman.*) These are the only observations you wish to make in reference to these tables?—Yes. A great many years ago I made a much more elaborate analysis of the sewage of the city, and got averages by taking a large number of samples on dry days and wet days and under different conditions at different points. The samples numbered altogether 40. I dealt with them in a paper on "The Chemical Composition and Fertilising Value of the Sewage of Dublin," delivered by me on the 15th January, 1865, before the Royal Dublin Society. In that paper I dealt with the whole subject of sewage disposal. It gives the quantity of solids in 100 tons of sewage, based on the 40 analyses, which I think gave very fair results. Without going into minute details I would like to refer to one or two points in the paper. There were 42·1lbs. of solid matter in 100 tons of sewage in a state of solution, and there were mechanically suspended 18·32lbs., making a total of 60·42lbs. of solid matter in 100 tons of sewage, nearly the whole of the nitrogen being in solution. The nitrogen in solution was 16·5lbs., and in mechanical suspension only 2·48lbs., I calculated at that time, which is a good many years ago, but the position of the city has not materially altered, that the sewage annually produced in Dublin, calculated for that year on the rainfall and other data, would be 24,767,857 tons 3cwt. 2qrs. 12lbs. That is very minute, but it is based on figures, and I had to bring it out even to pounds. The money value I estimated at £179,840, calculating that each ingredient —ammonia, potash, and so on—would be valued as if they were constituents of artificial manures, but at the same time pointing out that owing to the extreme solution that figure should be discounted, and that the value was very small. I hand in this paper in evidence:—

"The sewage of towns, although but little used as a fertiliser of the soil, has at least proved the fertile subject of calm discussions, angry controversies, lectures, newspaper articles, scientific papers, pamphlets, reports, commissions, experiments, and even Parliamentary inquiries. The problem—can the sewage of London be utilised?—has during the last twenty years occupied the attention of capitalists, engineers, chemists, agriculturists, sanitary reformers, and imperial and civic legislators; yet, notwithstanding all that has been done and said relative to this important problem, it still awaits a practical solution. There are two points in relation to sewage upon which the public have pronounced a decided and unanimous opinion, namely, the necessity for its complete and expeditious removal from towns, and the desirability of subsequently turning it to useful account by applying it to the soil. Every other aspect of the sewage question is, however, regarded from different, and, in many cases, even opposite, points of view. The engineers are not unanimous as to the best mode of conveying the sewage from the towns to the points of distribution; the chemists have not accurately determined its composition, and even the agriculturists are not agreed as to the kinds of crops to which this manure is adapted, nor have they decided upon the proper quantities in which, under certain circumstances, it should be applied. This, then, is the somewhat unsatisfactory condition of the sewage question, at a time when it comes prominently under the notice of the citizens of Dublin. The interest attachable to it is no longer confined to the inhabitants of London and those of a few other cities and towns across the channel, for a project to utilise the sewage of Dublin is actually afloat, and its promoters promise to be amongst the first to solve one of the most important social problems of this age. I am no more interested in the success of this scheme than every citizen of Dublin should be, and it is merely the statements in relation to it which have been made public that have led me to prepare a paper on the sewage of Dublin, which the council of this society have kindly granted me permission to read before its members.

"The question as to the practicability of using the sewage of large towns for manurial purposes has been for so long a period discussed by so many able men that but little originality need be expected in the present paper. In fact, my chief object in reading it is simply to elicit a discussion, by a competent assembly, on a subject which is likely before long to affect the ratepayer of this city in a most sensitive and hitherto very vulnerable point, namely, his pocket. The gentlemen who propose to apply to a useful purpose the sewage of Dublin are not, it would appear, disposed to undertake the collection of that article. They propose that it be delivered to them at points close to the estuary of the river, and they even go so far as to say to the citizens, 'We will not give you a farthing for all the sewage you may give us, unless the profits which may result from its application pay more than a fair percentage upon the capital embarked in the undertaking; in that case we will divide our surplus profits with you.' In order, therefore, to be in a position to comply with the terms of the sewage company, the Corporation must construct two huge sewers, paralled to, or beneath, the quays. The promoters of the company appear to have been advised as to the probable cost of constructing these sewers, seeing that they propose lending to the Corporation for that purpose the sum of £80,000 at five per cent. The making of the intercepting sewers may not cost quite that large sum, and it may cost a larger sum; but, no doubt, the outlay will certainly exceed £60,000, and probably may closely approach £100,000. The questions, then, which the citizens of Dublin are deeply interested in are—firstly, is it desirable to prevent, at a cost of from £50,000 to £100,000, the Liffey from continuing to be an open sewer? secondly, are the facts in relation to the applications of sewage such as would justify a reasonable expectation that the operations of the proposed sewage company would prove so remunerative as to be a source of revenue to the Corporation as well as to the company? These questions I propose to discuss in this paper.

"SANITARY ASPECT OF THE SEWAGE QUESTION.

"There is no doubt but that in the long run the agricultural and civic interests involved in the question of sewage will be found to coincide, but the onus of taking the first step towards the solution of this problem rests on the authorities of the towns. That agriculture sustains a loss, so long as the sewage of towns is poured into the ocean, is quite true; but that loss is a mere negative evil, whilst the presence of this baneful stuff in the midst of a crowded city is a positive injury to its inhabitants. Are the citizens to tolerate the existence of an evil amongst them which annually sends no inconsiderable proportion of them to the grave, simply because those to whom that evil would prove a benefit exhibit no anxiety to take advantage of it! To the farmer the aspect of the sewage question is simply a pecuniary one, and were he never to be supplied with the commodity he would not, as a rule, be the worse off; but to the citizen the removal of the sewage is a matter of life or death. I venture to assert, without fear of contradiction, that if this city were thoroughly sewered, and the contents of these sewers prevented from flowing into the river, the Registrar-General would have fewer deaths to record in his mortuary tables. Many of the diseases which prove fatal are the results of breathing an atmosphere rendered impure by the exhalations from animal ejesta. A considerable proportion of the deaths which annually take place in Dublin proceeds from what have been so aptly termed preventable diseases. During the year 1864 6,200 persons died in this city, and of these 5 per cent. at least perished from maladies which

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the observance of strict sanitary precautions would almost completely exclude from our city. Last year the number of deaths amounted to 2·5 per cent. of the population. The Census Commissioners in 1861 obtained returns from the registers of the cemeteries and graveyards in and near Dublin. From these returns it was found that there had been buried annually for some years an average of 2·9 per cent. of the residents within the municipal boundaries. As the sanitary conditions of the city have evidently been somewhat amended of late years, this improvement in the state of the public health is easily accounted for, but in this respect much yet remains to be accomplished. If it be true, then, that the perfection of our incomplete sewage system and the preservation of the waters of our river from pollution would annually prolong the lives or health of even two or three hundreds of the inhabitants of this city, then, I say, its Corporation would be justified—nay, more than justified—in incurring any reasonable expense in achieving objects of such vital importance. As a proof that I am not exaggerating the malign influence which the exhalations of open sewers exercise upon the public health, I need but refer to the case of Croydon. Some years ago the sewage of that town was discharged into the River Wandle, the water of which in consequence became so impure that persons lower down the river could make no use of it for domestic or other purposes. Under those circumstances some parties who possessed an interest in the water power afforded by the river instituted proceedings against the Corporation of Croydon, with the view of compelling them to allow the river to pass unpolluted through the town. The Corporation were defeated, and, after numerous unsuccessful attempts to deodorise the sewage, they were at last obliged to lease about 300 acres of land for the purpose of pouring the sewage over it, and getting rid of it in that way. They subsequently let the land thus irrigated at a rent of £300 per annum greater than that paid for it by themselves; but, owing to the law-suits and to the attempts to deodorise the sewage by removing, in a solid state, its fertilising matters, this practical solution of the sewage question, unfortunately, cost the people of Croydon no less than £40,000 for an income of £300 per annum. In one respect, however, and that a most important one, this mode of disposing of their sewage has been productive of the happiest consequences, for it is stated that the annual death rate in their town and the adjacent districts immediately after sensibly declined. Here, then, we have the best evidence—that afforded by accurate statistics—to show that the thorough and speedy removal of the sewage of a town promotes, in a remarkable manner, the longevity of its inhabitants.

"Since the subject of the waste of the excrementitious matters produced in towns began to attract public attention, many persons have suggested the complete separation of the liquid, and the solid excreta of men, from the fluid which converts them into sewage. All the attempts, and they have been many and costly, to separate the valuable ingredients of sewage from the water in which they are in so excessively diluted a condition have failed. Nearly 90 per cent. of the solid matter dissolved in the sewage cannot be precipitated from it by other than processes so costly as to totally preclude their economic application. But, then, it may be urged, why mix at all the animal fertilisers produced in the city with so prodigious a volume of water? why deprive agriculture of so useful and so portable a manure I answer: To the citizen sanitary considerations are primary considerations; it is impossible to remove excrementitious matter from our houses unless by mixing it with abundance of water. I am therefore totally opposed to the plan so constantly suggested to treat our liquid and solid ejesta after the manner of the Chinese. In the Celestial Empire, as travellers tell us, altars to Cloacina—at which visitors as well as the inmates may worship—form a conspicuous object in the dwellings of the inhabitants, and certain natural operations which in the rural parts of these countries are frequently performed beneath the shelter of a friendly hedge, are in the 'flowery land' conducted on the roadside, and with appliances provided by the nearest farmer. Something like this system of manure preservation is to be found in Belgium; but I believe it will never prevail in these countries, where it is so much opposed to all our notions of sentiment and decency, the tendency of which is to keep such matters as much as possible in the background. It would be far better that every particle of fertilising matter produced in the city should be continued to be discharged into the thankless ocean rather than we should revert to the old system of privies and cesspools. It has been suggested that water-closets, communicating with sewers, should be completely done away with, and that the excrements, liquid and solid, should be received into close vessels, containing earth or some other deodorising substance. In this way, it is contended by those possessed of that dangerous kind of lore—a little learning—the valuable manure produced in cities may be rendered innocuous and portable. Leaving out of the question such considerations as the enormous quantity of earth which would be required to supply the wants of the 25,000 houses constituting this city, it may fairly be doubted that such a plan would pay its own expenses. In the city of Manchester the system of cesspools still largely prevails. The Corporation discharge the duty of emptying these cesspools, and at a cost to the city of about £20,000 per annum. Of this large sum about £10,000 are recoverable by the sale of the manure, but still the large deficit remains. I believe, then, that if our Corporation undertook to remove the contents of the privies and cesspools that still remain in the city, they would find their operations in that line anything but profitable. There is no doubt but that the present mode of getting rid of the waste matters produced in Dublin is incomparably superior to the old plan of cesspools, and anyone who takes the trouble of studying this question will see that in every city in England in which there is no system of sewers the rate of mortality is very high. Since the abandonment of the cesspool system in London the public health in that city has wonderfully improved.

"The citizens of Dublin have incurred very heavy pecuniary liabilities in their desire to procure a plentiful supply of pure water, and I have no doubt but that their health will benefit by that display of liberality. But I firmly believe that the question of good sewage is of greater importance than any that has arisen with respect to the relative qualities of the Vartry water and that furnished by the canals. And to me it is quite clear that the sanitary state of Dublin must continue defective until every house in it communicates with a great central drain, and the waters of the Liffey pass undefiled through the city.

"FERTILIZING PROPERTIES OF SEWAGE.

"With respect to the fertilizing value of sewage, I may say at once that I am one of those who believe it to be very great when applied under certain conditions, which I will presently indicate. It has failed to satisfy the expectations of some people who had previously entertained a high opinion of its efficacy. On the other hand, many who doubted its utility have lately seen good reason to change their opinions. I will briefly describe the results of the use of town sewage in a few of the places in which it has gotten a fair trial. The sewage of the old part of the city of Edinburgh has for a long period of time been employed for irrigating meadows; and the grass farm of Mr. Miller, at Craigentinny, has for many years been held up as an example of the wonderful fertilizing power of sewage. This farm consists of 250 acres of land reclaimed from the sea, and which at one time was let at 4s. or 5s. an acre. Over this farm the sewage derived from a district inhabited by 80,000 souls is poured: nothing save grass is grown; and the amount of the produce, which it is stated, is annually obtained is almost incredible—three or four, and even five heavy crops have been obtained in one year, and that too in a rigorous northern climate. The Craigentinny meadows are let to dairymen of Edinburgh at an average rent of £22 per acre. With respect to the disposal of its sewage, Edinburgh is far more favourably situated than any other large city in the empire; its site being much higher than the surface of the surrounding country the mere force of gravity conducts its sewage to the meadows which it irrigates. Formerly about 2,000 acres were irrigated by the Edinburgh sewage; but the spread of buildings, and other causes, have reduced that number by more than one half. At Rugby, sewage has been applied to agricultural purposes for some years past; and Mr. Walker, a gentleman in the neighbourhood, receives the whole amount produced in the town, for which he pays a rent of £50 per annum. In 1861 a Royal Commission was appointed to experiment on the sewage of Rugby. The object was to determine the quantity and composition of grass produced on land, a portion of which was to be manured with sewage, and another portion to remain unmanured. Fifteen acres were divided into three equal parts—one for grass on which cows were to be fed, another for grass on which oxen were to be fed, and the third was to be meadowed. Each of these five acre divisions was

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further sub-divided into four plots, one of which was left unmanured, and the others received respectively different quantities of sewage. Some of the results obtained are tabulated in the following table:—

"PRODUCE GIVEN TO OXEN.

Plot.	Sewage required per annum.	Actually applied to end of October.	Total Grass per acre.	Increase of Grass per 1,000 tons of Sewage.
			tons cwts. qrs. lbs.	tons cwts. qrs. lbs.
1	–	–	9 5 3 5	—
2	3,000	1,872	14 16 3 8	2 19 1 7
3	6,000	4,423	27 1 0 10	4 0 1 9
4	9,000	6,153	32 16 3 8	3 16 2 9

"On the grass given to the milch cows the effects of the sewage were still more favourable, as will be seen in the following table:—

"PRODUCE GIVEN TO MILCH COWS.

Sewage applied.	No. of weeks the produce kept a Cow.	Gallons of Milk per acre.	Value of Milk at 8*d.* per gallon.	Value of Milk from increased produce of 1,000 tons Sewage.
			£. *s.* *d.*	£. *s.* *d.*
–	19	321	10 14 3	5 – –
1,387	40·9	570·7	19 – 6	5 19 10
2,804	58·8	820·4	27 6 11	5 16 8
4,226	68·9	961·3	32 – 10	5 – 11

"In these trials it is shown that the application of sewage was attended by a very great increase in the produce of grass. 'Deducting the value of the milk from the grass of the unsewaged from that of each of the sewaged acres, reckoning it at 8d. per gallon, it appears that where about 1,400 tons of sewage were applied, during the seven months, the produce calculated for each 1,000 tons of sewage actually applied gave an increased amount of milk to the value of £5 19s. 10d.; where twice that amount of sewage was applied, £5 18s. 8d., and where three times the quantity, £5 0s. 11d.' The value of the milk obtained from an acre of unsewaged grass was only £10 14s. 3d., whilst from the most highly sewaged grass the value of the milk amounted to no less than £32 0s. 10d. The Rugby experiments, which were conducted under the direction of Mr. J. B. Lawes—so well known for his invaluable chemico-agricultural investigations—have been considered somewhat unsatisfactory, on the ground that the sewage was not always applied at the proper time; and Mr. Walker states that the fields were flooded to such an extent as to seriously deteriorate the quality of the herbage. Mr. Lawes admits that the experiments were in some respects so conducted that their results would not appear so favourable to the sewage as under proper conditions would have been the case; but still the great fact remains that land abundantly sewaged is capable of producing three times as much milk as the same kind of land when unsewaged. The sewage of the small town of Ashburton, in Devonshire, is distributed over the greater part of a valley which lies close to the town; the sewaged portion of the valley lets at the rate of £6 per acre, whilst the rent commanded by the unsewaged fields is only £1 per acre. The sewage of Mansfield is poured over lands in the vicinity of the town, which in consequence have been raised in value from 3s. per acre to £12 per acre. The sewage of Carlisle, of Leicester, of Watford, and of two or three other towns, is applied to the useful purpose of fertilizing the soil; and although pecuniary failures in some instances have arisen from futile attempts to concentrate the sewage or to distribute it over too wide an area, still in every case the remarkable manurial power of the article is strikingly exhibited.

"On the Continent the sewage of towns is in some places utilised on a large scale. Some time ago our Government appointed a Commission, composed of Messrs. Way, Austin, and Southwood Smith, to draw up a report on the system of irrigation followed in the north of Italy. In this report it is stated that the sewage of the city of Milan is employed in irrigating about 4,000 acres of land situated at a distance of a few miles from the city. Each acre receives annually about 9,000 tons of sewage in which are contained the ejestæ of forty persons. This land possesses an extraordinary degree of fertility, and becomes so charged with rich organic matter that its surface is periodically pared and the parings used to manure other lands not so favourably circumstanced. A Dr. Chiappa has a farm of 580 acres near Milan, which is manured with the sewage of the city. The portion devoted to grass contains 80 acres, yielding annually 22 tons of produce per acre. The grass is partly made into hay, partly consumed in the green state, and is found sufficient to maintain 100 cows. It is calculated that the 9,000 tons of sewage applied to each acre are equivalent to £4 8s. worth of well decomposed manure; but it must be observed that the sewage of Milan is commingled with the water of the river Vettabia, and is consequently more dilute than the sewage of Dublin. The conclusions at which these commissioners arrived were chiefly as follows:—That the experience of the application of sewage in the neighbourhood of Milan affords a striking illustration of the immense advantage which the command of large quantities of mere water alone confers upon agriculture; that the fertilizing virtues of the water are enormously increased by the addition of sewage, and by its temperature being raised by its passage through a town; that the health of the population of the districts manured with sewage is not worse than that of the population of regions in which pure water irrigation is carried on; that notwithstanding the elevated temperature of Italy, no disagreeably odorous emanations arise from the sewaged fields; and, finally, the Commissioners condemn in very decided terms the folly and extravagance of the British people why by most expensive arrangements seek to get rid of a manure which ought to be equivalent to the annual exportation of many hundred thousand tons of guano.

"With respect to the application of sewage derived from manufactories, public institutions, and other large establishments and villages, there is abundant evidence to show that the general results have been satisfactory. Alderman Mechi states that the use of sewage on his celebrated form at Tiptree Hall proved highly productive and remunerative. The Earl of Essex has constantly employed sewage manure since, I believe, 1857, and with an extraordinary degree of success. This nobleman states that he has obtained from sewaged meadows the large produce of 46 tons per acre, whilst from the same quality of meadow, which had not been sewaged, the produce amounted only to from 7 to 8 tons. On the Earl of Essex's farm an application of 270 tons of sewage per acre of mangels, produced a yield of 43 tons, or about double the average produced of that crop in England. Latterly the earl has restricted the application of the sewage to grass lands. Even in the case of market gardens the use of sewage has proved profitable. In the number of the *Irish Farmer's Gazette* for 27th August, 1859, Mr. R. O. Pringle gives an interesting account of the results of the application of sewage at Mr. Niven's celebrated garden farm, Drumcondra, co. Dublin:—'The system of liquid manure which has been adopted at this farm is very simple. At the upper end of the field there is a large tank, which is kept full of liquid manure of the best description derived from the High Park Reformatory. Before Mr. Niven got this portion of the ground all the sewage from that establishment was discharged into an open ditch, and was, in fact, a great nuisance, as well as likely to prove prejudicial to the health of the inmates. By an arrangement with the managers of the institution, Mr. Niven was permitted to throw pipes across the old ditch and convey the sewage into his own tank; and some idea of its value will be gathered from the fact that the consumption of soap alone in the reformatory is nearly a ton a week, producing an immense quantity of suds, which, with other materials, combine to form a most valuable manure.' At the time of Mr. Pringle's visit there was a fine crop of kemp potatoes which had been manured with sewage only, and which, up to 11th August, had furnished 11½ tons per acre, a considerable quantity still remaining in the ground. When we consider that market gardens require the largest supplies of manure, and that those in the neighbourhood of London sometimes receive 120 tons of natural manure per acre, I think the case of the garden farm at Drum-

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condra indisputably proves that sewage is capable of supplying the wants of every kind of crop. This morning I received a letter from Mr. Niven, in which he states that he continues to use, in conjunction with a small proportion of stable manure, the sewage, and that he even applies it to fruit-bearing trees. He says that the effects on the vine and peach trees are 'amazing.' Here, then, we have a nursery and market garden consisting of 30 acres maintained in the highest state of fertility by the sewage derived from a single establishment, the inmates of which do not exceed 80 in number.

"The Most Suitable Crops and Soils for Sewage.

"With respect to the kinds of crops to which sewage is most adapted, it appears to be admitted on all sides that the natural and artificial grasses are those that have hitherto been most benefited by its application. There are, however, on record the results of experiments which go far to prove that sewage may under certain circumstances be usefully applied on tillage farms. As a general rule the constituents of a manure are rendered more efficacious by dissolution in large quantities of water, because they are certain to be thereby equably distributed throughout the soil, and each of the plants they are intended to nourish will obtain its fair share.

"The advantages of using manure in the form of a dilute solution are clearly shown in Mr. Rustun's paper in the 20th volume of the Journal of the Royal Agricultural Society of England. This gentleman obtained a large increase in all his crops—grass, green and white—by simply applying the manure for each acre commingled with about 4,000lbs. weight of water. As a general rule, however, I believe that town sewage, which is an excessively dilute solution of manure, cannot be employed to any great extent on tillage farms, more especially on those that are not thoroughly drained.

"Light or medium soils resting on a sandy subsoil will be found the best absorbents of sewage, although their power of retaining the fertilizing ingredients is not so great as that of heavy clays. On stiff clay lands, the chief fault of which is their impertransible nature, large dressings of town sewage would not be beneficial—nay, would be the reverse: the fluid would rest on the surface, and render the soil so cold and wet as to be decidedly injurious to most plants. Land of any kind under cereals cannot constantly be the scene of sewage irrigation, for during the long period of the year devoted to the preparation of the ground, a dry and easily pulverulent condition of the staple is desirable, and during the ripening of the crop, heat and a very moderate degree of humidity are necessary. It is clear, then, that cereal crops could only be benefited by very moderate doses of sewage applied at only certain periods of the year. Still, where sewage is available, I believe that both white and green crops would be largely served. by its use; and if it were in a more concentrated condition than that derived from large towns is, it might be applied during by far the greater part of the year. The use of dilute sewage on a tillage farm being, therefore very restricted, it would be unwise to attempt to supply the tillage farmers of a wide area with the drainage of a city like Dublin. Gas companies often find it unprofitable to lay down pipes to certain districts remote from their works, although their commodity is sold at the rate of 4s. or 5s. per thousand cubic feet. It would be still more unwise were sewage utilisation companies to attempt the laying down of pipes over a wide district in order to supply an article at the rate of only 1d. or 1½d. per ton. Grass lands are in a very different condition with respect to sewage; they are ready at almost any time for the reception of that manure; and their produce is, within certain limits, proportionate to the amount of sewage applied.

"Proper Quantity of Sewage to be Applied per Acre.

"With respect to the proper quantities of sewage to apply to grass, considerable difference of opinion prevails. Very different estimates have been made relative to the actual quantities which annually flow over the Craigentinny meadows. Mr. James Hope sets it down at 2,000 tons per acre; Mr. Miller states it to be 4,000 tons; the late Mr. Austin, C.E., estimated it at 8,000 tons; whilst Professor Anderson considers it to amount to 14,000 tons. As these meadows receive the sewage of a district inhabited by 80,000 persons, Dr. Anderson's estimate is probably the nearest to fact. It is quite certain that the Edinburgh meadows receive enormous quantities of sewage which do not appear to have exercised any injurious effect upon the nature of the grasses grown thereon, except in rendering them exceedingly succulent. This disproves the statement made by certain writers that large doses of sewage render the herbage of meadows very coarse and inferior. No doubt in the case of retentive soils continued floodings of either sewage or pure water would render the herbage coarse, but where provision is made for the moderately rapid passage of the liquid throughout, and from, the soil, very large quantities of sewage will not injuriously affect the herbage grown upon it. Several authorities upon this subject contend that moderate dressings of sewage—from 2,000 to 5,000 tons per acre per annum—give in the end better results than excessive applications, whilst Mr. Lawes states in his evidence before the select committee on the sewage of towns, that if he got it for nothing he would apply 70,000 tons of sewage to an acre, or, he adds 'anything you like to give me.' Mr. Westwood, late farm bailiff to the schools at Anerley, stated before the committee that he obtained as large a return from two acres of rye grass to which 1,500 tons of sewage had been applied per annum, as from two other acres which had been manured with between 8,000 and 9,000 tons. As this witness had been obliged to furnish accurate returns relative to the farm under his management to the Government Inspector, the select committee appear to have attached great weight to his evidence. It appears to me that the pouring of 20,000 or 30,000 tons of sewage over an acre of grass is a useless expenditure of the greater part of the fertilizing matters contained therein; and I have no doubt but that the Craigentinny meadows would yield as good crops as they do at present were their present supply of sewage curtailed by three-fourths of the amount. The evidence given in the report of the select committee on the sewage of towns, is certainly on the whole in favour of light dressings, as against heavy floodings.

"Composition and Value of the Sewage of Dublin.

"In relation to the chemical compositions and commercial value of sewage, the greatest variety of opinion prevails, especially with respect to the latter point; some place so low a value as ½d. per ton upon the article, whilst others estimate its money value at from 1d. to 9d. per ton. Sir Charles Fox believes it to be worth 1½d. per ton; Dr. Hoffman sets it down at 2d.; Mr. Lawes says that if obliged to take it at all times the value of the water alone for irrigating purposes at 2d. per ton. In 1857 I made several analyses of the sewage of Dublin, the result of which are published in my work on Agricultural Chemistry.* From the results of these analyses I estimated the money value of the sewage to be something less than 1¾d. per ton. It is very difficult to arrive at an accurate knowledge of the composition of the sewage of a large city, owing to the many disturbing influences which affect it. The rainfall, the supply of water in each locality, the food of the inhabitants of the district, and the hour at which the article is collected, are all important points which must be taken into consideration in estimating the average value of a ton of sewage. Quite recently I have made an analysis of sewage, consisting of a mixture of no fewer than 40 samples, selected at different hours during both day and night, from different sewers at their outlet into the river. I find on comparing the results of this analysis with those obtained in 1857, that there exists a close agreement between them.

"According to the results obtained by my last analysis, 100 tons of the sewage of Dublin contain the following fertilizing ingredients:—

"1st. In complete solution—

	lbs.		£.			£.	s.	d.
Nitrogen - - -	16·50	at	70	per ton	-	–	10	3·75
Phosphoric acid -	3·85	„	40	„	-	–	1	4·50
Salts of potash - -	5·12	„	20	„	-	–	–	10·97
Salts of soda - -	16·63	„	1	„	-	–	–	1·78
Total - - -					£.	–	12	9·00

"2nd. Mechanically suspended—

	lbs.		£.	s.					
Nitrogen - - -	2·48	at	70	–	per ton	-	–	1	6·60
Insoluble phosphate of lime.	1·84	„	8	–	„	-	–	–	1·57
Organic matter -	14·00	„	–	10	„	-	–	–	0·75
Total - - -						£.	–	1	8·92
Grand Total - - -						£.	–	14	5·92

* Chemistry of Agriculture. Dublin: Kelly, Grafton Street; 1857.

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"The sewage, the analysis of which I have stated above, was collected on three consecutive days; and I find by reference to the meteorological tables published in the Registrar-General's returns of births and deaths that the amount of rain which descended upon those days happens to be the average for the whole year. I think, therefore, that the sewage examined by me somewhat closely resembles the average quality of the article throughout the year.

"With respect to the amount of sewage annually produced in Dublin, I have made the following calculations:—The present supply of pipe water is about 9,500,000 gallons per day; the average daily rainfall over the sewered districts is about 5,700,000 gallons. The amount of sewage, therefore, which passes daily into the sewers is 15,200,000 gallons, or 67,857 tons 2 cwt. 3 qrs. 12lbs., which, at the rate of 14s. 5·92d. per 100 tons, would have a money value of £481 14s. 9½d. From these data it will be found that the sewage annually produced in Dublin amounts to 24,767,857 tons 3 cwts. 2 qrs. 12lbs., the money value of which is £179,484 7s. 4·8d. I am aware that many persons will consider this estimate of the money value of the sewage of Dublin to be excessive, but I have simply placed the same value upon its various ingredients as I would if they entered into the composition of guano or of other artificial manures. If one hundred tons of this sewage were gradually distributed over an acre of land, under any kind of crop, I believe it would be good value for 14s.; but, under ordinary circumstances, so large a quantity of sewage is applied per acre that a large proportion of its soluble ingredients passes away from the soil.

"The greater part of the most valuable ingredient of the sewage, namely, its nitrogen, is in the form of urea. This substance, I proved by experiments, performed in 1856 (and described in a paper read before the British Association at their meeting in 1857), to be capable of directly furnishing nitrogen to plants; but Liebig has since then shown that it passes readily out of the soil—a negative quality which is a great drawback to its use as a manure. Soils possess the remarkable property of removing from their solutions such substances as potash and phosphoric acid, which furnish food to plants. When sewage water is poured over the land, the soil seizes upon and retains the ammonia, phosphoric acid, and potash present in it, but allows the urea to pass through. This curious absorptive power of soils has, however, its limits, so that if an excessive quantity of sewage be poured over a field, a large portion of it, and more especially its urea, will not be permanently retained by the soil. Owing to these circumstances, and to the fact that the sewage flows at times that it is not required, the actual value of the drainage of this city will not correspond with the theoretical estimate which I have given. If, however, the sewage be applied to an area of 8,000 acres of grass land, its money value will be found to be not much short of £80,000 a year.

The value of the sewage of a town may be ascertained by other means than the analysis of the article. By determining the actual value of the ejesta of an average unit of the population of a town and by ascertaining the number of its inhabitants, a pretty close estimate of the value of its sewage (provided, of course, that all the waste matters pass into drains) may be formed. Unfortunately, however, there are considerable differences of opinion as to the manurial value of the excrements of an individual, averaging all ages and both sexes. Dr. Hoffman and Mr. Witt estimate them at 10s. 10d. per annum, while Professor Anderson sets them down at 6s. Whilst agreeing with Professor Anderson as to the amounts of potash, phosphoric acid and ammonia, yielded by a unit of the population, I differ from him as to the prices which should be placed on some of these ingredients. Dr. Anderson states that an adult male excretes daily the following quantities of valuable matters:—

	In Urine.	In Fæces.
Nitrogen	214 grains	21 grains.
Equal to ammonia	260 "	29 "
Phosphoric acid	50 "	25 "
Potash	45 "	5 "

"This gives for the total annual production:—

Ammonia	15 lbs.
Phosphoric acid	3·3 "
Potash	3 "

"On these substances the value of the whole depends; for though there are other constituents, their quantity is so small and their manurial importance so trifling, that they may be left out of consideration. If the valuable matters be taken at the price at which they are sold in guano, then the annual value will be:—

	s.	d.
15 lbs. of ammonia at 6*d.*	7	6
3·3 " of phosphoric acid at 1½*d.*	–	5
3 " of potash at 2½*d.*	–	7½
Total Value	8	6½

This estimate, it will be noticed, applies to the excretion of the adult healthy male. Those of the female are less valuable by a fifth; and of children the amount and consequent value depends upon their age. In fact, the quantity goes on gradually increasing to the period of maturity, and then again diminishes when the bodily functions become less active towards the close of life. When the proper allowance is made for these (for which a rather elaborate calculation is required, into the details of which it is unnecessary to enter), it appears that the average value of the substances contained in the solid and liquid refuse for the whole population of both sexes and all ages is almost exactly two-thirds of that above given, or, in round numbers, 6s. per head."

"From the above it will be seen that Dr. Anderson values ammonia at £56 per ton, and phosphoric acid at £18 per ton. I, however, value ammonia at £70 per ton, and the soluble phosphoric acid in sewage at £40 per ton. The soluble phosphoric acid in superphosphate of lime and other artificial manures is valued by chemists at a higher rate than this. I also place a value upon the soda salts and the organic matters. Affixing, therefore, a higher value to some of the ingredients of excrements than Dr. Anderson does, I consider the amount annually produced by each individual to be worth 8s. In 1861 the population of Dublin within the municipal boundaries amounted to 254,808. A great number of persons residing in the suburbs, but employed during the day in the city, are not included in the census. There are sewers from a few suburban places which empty themselves into the Liffey. We may assume, then, that the sewage of Dublin which flows into the Liffey contains the mixed excrements of 260,000 persons, worth, at 8s. per head, £104,000. This sum is, however, far short of the amount which I have already stated I considered the sewage of Dublin to be worth, but the difference may partly be accounted for as follows:—In 1862 there were within the municipal boundaries 7,365 horses, 78 mules, 572 asses, 762 heads of horned cattle (including 602 milch cows), 773 sheep, 7,558 pigs, and 1,589 goats; total, 18,697 animals. The census of these animals was taken in summer, when the greater numbers of the horned stock belonging to the dairies were pastured in the rural districts. In winter the milch cows are more numerous in the city, and their liquid excrement no doubt improves the sewage as a manure. The quantity of liquid excrement formed by a cow is at least seven times greater than that voided by a man; and it is almost needless to remark that the ejesta of a horse is much more valuable than that from a man. I am under the mark when I put down the average value of the manure produced from each of the animals above-mentioned at £1 per annum or a total of £18,697, which, added to the value of the human effete matter, makes up the sum of £122,697. The soap suds, refuse parts of food, slops of all kinds from private dwellings, the excrements of thousands of dogs, cats, and birds, and the waste matters from manufactories, which find their way into the sewers must be worth a large sum as manure. We must also take into account the ammonia and nitric acid which are carried down from the atmosphere into the soil, and are found in the sewage. Even the saline and organic matters contained in the pipe and drainage water, inconsiderable as their amount is when compared with the quantity of pure fluid, come to have no small value when millions of tons of water are dealt with. I venture to say that the potash, soda, and other fertilizing matters contained in 24,000,000 tons of river water, undefiled with sewage, would, if valued at the same rate as if they were constituents of artificial manures, be worth a large sum.

"I have endeavoured to show that the estimate which I have made of the value of the sewage of Dublin, as deduced from the results of my analysis of that fluid, is not very much higher than the estimate based upon the assumed value of the ejesta of the population, and other effete matter produced in towns. Any difference that may exist must be attributed to the difficulty of obtaining an average sample of the sewage, rather than to the value of the excrements being understated.

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"PROBABILITY OF THE UTILISATION OF THE SEWAGE OF LONDON AND DUBLIN.

"That the public are at length awakened to the fact that they have at their very doors sources of manure, rivalling in extent the Guano Islands of Peru, is evident from the eagerness which capitalists now evince to secure possession of the sewage of London. One company proposes embarking the colossal capital of £6,200,787 in this undertaking, and if granted the use of the whole sewage of the metropolis, they believe that their operations would realise a profit of 30 per cent., a fair proportion of which would be paid over to the Board of Works. The persons who represented this company offered to prove the *bonâ fide* nature of their application by depositing the sum of £60,000 with the Board of Works, on the condition that it should be forfeited if the company failed to fulfil their engagements. Resolutions in favour of this company's scheme were passed during the present year at a great many of the parochial meetings. Another company proposes to convey the sewage by culvert and embankment to the Maplin Sands, in Essex, a distance of 44 miles. These sands it is proposed should be reclaimed in the ordinary manner, and fertilised by the sewage. The area to be reclaimed amounts to 12,000 acres, and the cost of the undertaking is set down at £2,000,000. This scheme, which appears to stand well with the Board of Works, deals only with the sewage of North London. There are several other projects for utilising the sewage of London afloat, and there is no doubt but that before long some one of them will be adopted and carried out.

"Dublin is somewhat more favourably situated with respect to the economic disposal of its sewage than London. It is nearer the coast, where the land best adapted for sewage operations is alone obtainable. I am opposed to the proposal so frequently made to lay down a system of pipes for the purpose of selling the sewage to farmers. The price obtained for the sewage, if, indeed, farmers could be persuaded to purchase the article, would not pay for the cost of its distribution. In fact, the use of sewage can only yield very satisfactory returns when it is one of the means made use of in the formation of slob lands. At Lough Swilly several thousand acres have been reclaimed from the sea within a very recent period, and the operations have, wherever they were fully completed, realised a good profit. The rent of this slob land varies from 18s. to £2 per acre, but some of it is very poor, owing to the want of manure. This is the kind of land which would drink up enormous quantities of sewage and produce correspondingly large crops. I understand that the company who propose to apply the sewage of Dublin intend to effect the reclamation of about 2,400 acres of sandy wastes, lying between the North Bull wall and Sutton, and to convert them into dairy farms. I believe this project contains all the elements of success. The reclamation of this slob land would be a profitable operation *per se;* but when every acre could, by the application of sewage, be rendered equal in productiveness to 10 acres of ordinary land, the operations must, in a pecuniary point of view, prove very remunerative. The only advantages which Edinburgh possesses over this city is that its sewage flows over the irrigated lands by the force of gravity alone. However, the cost of pumping the sewage of this city up to a height sufficient to give it a fall towards the North Bull would not be very great. The trials made with 25 Cornish steam pumping engines in 1851 showed that on the average the combustion of one cwt. of coal would, by means of one of those mechanisms, raise 1,600,000 gallons of water a foot high. With these data I calculate that the whole of the Dublin sewage, amounting annually to 24,767,857 tons, could be raised to the height of 15 feet* by the combustion of 2,580 tons 12½ cwt. of coal, which, at 15s. a ton, would cost £1,935 9s. 4½d. This would be only 10 per cent. of the value of the sewage, and would not add £1 to the cost of the dressing of each acre; but here I would remark that the quantity of sewage annually produced in Dublin is sufficient to heavily manure at least 8,000 acres.

* Since my paper was read I have learned from Messrs. Barrington and Jeffers, that Mr. Hemans, the eminent engineer, has already made complete plans for the application of the sewage. He proposes pumping the sewage to a height of 18½ft. There will be no reservoir; only a pumping well. The fall of the sewage will be 2½ft. per mile to the pumping station, and from thence to the meadows 3ft. per mile. The lower end of the main sewer at the pumping station will be 11½ft. below high water mark at ordinary spring tides.

"EFFECT OF THE AGRICULTURAL APPLICATION OF THE DUBLIN SEWAGE UPON THE PUBLIC HEALTH.

"With respect to the purification of the river and bay, which would result from the application of the sewage of the city of Dublin, I need but remark that the insoluble ingredients in the latter amount annually to about 5,000 tons of absolutely dry matter, corresponding to at least 40,000 tons of fetid mud, which at present, like waifs and strays, is tossed to and fro by the tide, discharging fever-breeding gases and vapours into the air.

"Since the subject of utilising the sewage of towns has become a popular one, the question has arisen, will the application of sewage on a large scale injuriously affect the health of the people who may happen to live near the sewaged lands? In the case of a portion of the sewaged meadows near Edinburgh, there is no doubt but that gases, vapours, and putrescent particles are occasionally given off, which are extremely unpleasant to the sense of smell, and certainly are injurious to health. At Lochend and Roseburn the odour, especially during very warm weather, is most offensive, and the winds that constantly blow from either of these places into the city are anything but 'balmy breezes.' These malarious exhalations arise, however, to a great extent from the open drains through which the sewage flows. A large proportion of the effete matter produced in the 'old town' passes into a stream termed very characteristically the 'Foulburn.' This stream becomes an open sewer just beyond the eastern side of the town, and during the summer constantly evolves highly fetid gases and vapours. At Craigentinny, which is about two miles from the city, the sewage is poured over grass land, which speedily drinks it up, and completely deodorises it. I have on three occasions during warm weather visited the sewaged meadows at Craigentinny, and I am enabled to affirm from actual observation that the odour from them is almost inappreciable.

"The residents of Clontarf and Baldoyle no doubt feel alarmed at the probability of the sewage of Dublin being brought close to their doors; but if the thing be done properly there will be no real ground for apprehension. The natural destination of the excrements of animals is the earth and not the water. If the sewage of Dublin be brought by means of watertight conduits to the seaside, and deposited in an absorbent soil, it will not give off miasma.

"At present the fæcal matters produced in this city are thrown into the river and bay, in which they slowly decompose, evolving all the while pestiferous vapours. If deposited in the earth these vapours would not be given off, but would furnish food to plants. No doubt sewaged lands sometimes emit disagreeable odours and gases, but that is only when their absorbent and deodorising capabilities are too highly taxed. In the case of the Edinburgh meadows, from 10,000 to 15,000 tons of sewage per acre are annually poured over them—need we wonder then that some portion of this fluid remains on the surface to stagnate and produce miasma! If the Dublin Sewage Utilisation Company adopt the plan of moderate dressings—say 3,000 tons per acre—I feel quite confident that the scene of their operations will be far less offensive to our olfactory nerves than the strands at Clontarf and Irishtown now are when the tide is out. In any case the cost of deodorising the sewage before its application is not very great. M'Dougall's disinfecting fluid is capable of effecting this, at a cost of only a few pence per hundred tons.

"I fear I have spun out this paper to an inordinate length, but I trust that the importance of the subject will prove a fair excuse; and, thanking the council of the Royal Dublin Society for permitting me to bring it under the notice of this meeting, I will conclude, in the words of Liebeg:—'If clearly understood and properly managed, the employment of sewage will prove a blessing to agriculture, and those who, by unwearied perseverance, have at last seen the consummation of their labours, may justly be looked upon as the benefactors of their fellow men.'

"APPENDIX A.

"The sanitary question arising out of the proposed application of the sewage of Dublin has excited considerable discussion since the foregoing paper was read before the Royal Dublin Society. Several very influential persons, connected by ties of property or residence with the districts near which the sewage of

the city is proposed to be applied, are at present energetically opposing the project. Several eminent medical men, too, have expressed very strong opinions relative to the application of the city sewage to the sands at Clontarf, maintaining that if such a project were carried into effect the public health, not only in Clontarf and Baldoyle, but even in Dublin, would seriously suffer thereby. All these opinions are founded upon vague generalities; upon such scientific platitudes as the poisonous nature of the gases, etc., given off from putrefying organic matter; and finally upon the alleged evil effects of the sewage irrigation near Edinburgh. With respect to the Edinburgh meadows, no conclusion of general application can be drawn, because there the sewage is applied in such enormous quantities that the soil is utterly unable to properly absorb and deodorise it. In fact, the thing is overdone. That, however, sewage when properly utilised does not give off matters injurious to the public health, is evident from a letter which I have recently received from Dr. Sutherland, Medical Officer of Health for Croydon. In order to understand the full significance of Dr. Sutherland's statements it will be necessary to bear in mind that the estimated population of Croydon (parish) in 1864 amounted to 37,862. The number of houses is 6,585, of which 4,870 are in connection with the public sewers, the contents of which are used in irrigating 300 acres of grass land close to the town. Dr. Sutherland states:—'I think I can answer your second query with great confidence, that the public health has in no way been injured by the sewage irrigation.' 'It is the opinion of all persons here who have paid any attention to the subject, that the irrigation has been very successful in an agricultural point of view, and I can speak most favourably of it, as a sanitary measure.'

"Appendix B.

"Extracts from the First Report of the Committee of the House of Commons on Sewage of Towns, printed April, 1862.

"The Earl of Essex—Question 3—Will you inform the Committee as to the crops to which you apply the sewage, and to what result?—I have applied it, and with very great success, to a portion of the park which I may call meadow grass.

"Q. 22.—You apply the sewage, I presume, near your house?—Yes.

"Q. 24.—Have the men you employ to apply the sewage suffered in health?—Never in the slightest degree; I have had the same men sometims in the whole season on an average of eight or ten hours per day, and they had never had to complain in any one respect.

"J. B. Lawes, Esq.—Q. 310.—Were you one of the Royal Commissioners appointed in 1857 to inquire into the best mode of distributing the sewage of towns and applying it to beneficial uses?—I was.

"After referring to various experiments at Rugby, the Duke of Portland, etc.—Q. 494.—You use no deodorising substance?—No, none.

"Q. 495.—And I think you say the stink is nothing to talk of?—Nothing.

"Same witness before Lord Robert Montague's Committee in 1864.—Q. 4466.—What effect has sewage upon very sandy soils?—It is perhaps more adapted for a sandy soil than for any other.

"To Professor J. T. Way.—Q. 710.—You are, I believe, consulting chemist to the Royal Agricultural Society of England?—I was so until about three years ago.

"Q. 776.—You have made experiments on the power of soils to absorb the manure contained in sewage?—Yes.

"Q. 777.—Will you inform the Committee what were the results obtained by you?—The results generally were these, that in soils there resides a power which, previous to my examination, I believe was not recognised to separate from liquids containing manure, containing ammonia, for instance, and potash, and phosphoric acid, and magnesia, that is to say, all the important elements of manure; these elements, to separate them from water, not by mere filtration, because these things would pass through a filter, but by the peculiar chemical attraction possessed by the ingredients of a fertile soil for these liquids, so that if we were passing a liquid containing manurial matters through a given quantity of soil, the water would pass through, and these matters would be retained and fixed in the soil. I look upon this as a great arrangement and provision of nature for the preservation of manuring principles from being washed out of the soil by rains.

"Q. 778.—Did you find that the sewage water, after it percolated through the land, was very pure?—Yes, if not put on in very great excess, because, of course, the power of the soil ceases at a given point but you may put on sewage in very considerable quantity to the soil, and the liquid running there is perfectly bright and clear, and in a great measure deprived of its inoffensive manurial properties as well as of its offensive ones.

"Q. 779.—Then the land possesses the power to deodorise the sewage?—Quite so, in a very large degree.

Q. 780.—Supposing that the depth of an inch equal to 100 tons of London sewage was placed on an average meadow or grazing land, how soon might we expect to see it absorbed in the soil and deodorise?—The minute that it is on the soil and the liquid has vanished from the surface, there is no sort of smell; if you put it on a fallow soil you would not smell it many minutes after it was applied.

"Edward Frankland, Esq., Ph.D., F.R.S.—Q. 944.—Chairman.—You were instructed by the Metropolitan Board of Works to inquire into the deodorisation of the sewage?—I was.

"Q. 956.—Have you any observations to make with regard to the offensiveness or inoffensiveness of sewage being applied to land?—Yes. I have had some little experience of its effect after its application to land, and also as regards the sewage flowing in very hot weather from the mouths of the London sewers in the application of very concentrated and very nauseous sewage to land, I have found that the odour disappears almost immediately after the application, whilst the liquid from the London sewers, even in very hot weather in summer, is really not very disagreeable—its odour is remarkably slight.

"Q. 957.—It is only where it is kept stagnant that it becomes so offensive?—Quite so.

"Q. 958.—If sewage were pumped up to a reservoir passed from that point through pipes and spread on land judiciously, you would not anticipate much inconvenience as regards smell?—I should not.

"Q. 962.—You are then decidedly of opinion that deodorisation is not necessary to be gone through before the application of sewage to land?—Certainly not in ordinary seasons, and I even think that in very hot weather it would not be found necessary.

"J. T. Blackburn.—Q. 1838.—Chairman.—You have had some experience as a practical agriculturist, and also have studied agriculture as a science?—I have.

"Q. 1851.—In the application of liquid manure, such as sewage, you have observed its effect as regards its offensiveness or otherwise?—In the application of liquid and liquefied manures in a very concentrated state there is a certain amount of offensiveness during the application, but it is very soon absorbed, and the manure loses all smell—if it is properly diluted there is little or no smell. I have very frequently been on Lord Essex's ground during the application of sewage manure when there has been little or no offensiveness, even during the process of distribution.

"S. C. Miller, Esq.—Q. 3056.—You were formerly a member of this House?—I was.

"Q. 3084.—To which variety of soil do you find its sewage most applicable and most beneficial?—It is beneficial to all, but I think I should prefer a sandy soil.

"Q. 3140.—Are you surrounded by these meadows (Craigentinny meadows, near Edinburgh)?—Not quite surrounded in one or the other side of them.

"Q. 3141.—Do they approach near to you?—Within 100 yards.

"Q. 3143.—And you are never sensible of any disagreeable effluvia?—Not at all.

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"APPENDIX C.

Report of Committee, July, 1864.

"Mr. Ellis.—Q. 1921.—Do you consider that deodorisation is necessary?—Not at all.

"Q. 1922.—Do you not think that deodorisation is necessary?—It is quite useless; the sewage flowing from the outfall sewer has nearly the smell of damp cloth; it is not at all offensive.

"Q. 2021.—Have you heard of any annoyance being created by sewage when applied on the surface of the land?—I have heard of none.

"Robert Rawlinson, Esq.—Q. 3986.—Were you superintending-inspector under the first Board of Health in 1848?—Yes, I was.

"Q. 3987.—Were you Engineering Sanatory Commissioner to the British Army in the Crimea?—I was.

"Q. 3988.—And you are now a member of the Royal Sewage Commission appointed in 1857—are you not?—I am.

"Q. 4120.—If I told you of the sewage of 3,000 inhabitants being applied by nothing but the plough opening furrows in the fields with very great profit, and without the slightest annoyance to people living close to them, you would not be surprised—would you?—Not at all.

"Q. 4208.—You have given one answer with regard to the fact that landowners in the neighbourhood of towns have a repugnance to allowing the sewage of any large population to be brought upon their land, does not that arise from the belief which is generally entertained that it would create a nuisance?—No doubt it does, just for the same reason as many landowners object to a cemetery.

"Q. 4209. Would your experience lead you to say that no such nuisance need really be occasioned?—I am satisfied that if this room were a grass plot you might irrigate it every morning, and not leave any perceptible smell from it within half an hour after the irrigation.

"Q. 4250.—Are you aware that Mr. Way states that five minutes after the use of the sewage on land it is perfectly without a particle of smell?—It depends upon the land, but I believe it is practically so. If you had a sandy subsoil I do not think you would have any smell at all."

13036. In these days, was the system here a water-closet system, and is it still a water-closet system?—It was partly a water-closet system at that ime, but the water-closet system has enormously increased in Dublin since then—some 10,000 water-closets have been established since then. Within the last 15 years I have enstituted a regular crusade against petties. Dublin was originally largely a midden city, but within the last 15 years we have got 10,000 of these abolished, and water-closets have taken their places among the tenement houses, so that a larger quantity of that kind of sewage goes into the sewers than formerly. I have here eight specimens of sewage. The clear one is what came from the brewery direct.

13037. Without filtration?—Without mixing with other sewage.

13038. And without being filtered?—Yes, it has not been filtered; in fact, none of these samples have been treated at all.

13039. (*Colonel Harding.*) How long have the samples been in the bottles?—About ten days; I took portions of these sewages, and by merely passing them through bibulous paper I got a tolerably clear solution. I then mixed 10 per cent. of that with 90 per cent. of water taken from the bay near where we propose to pass the sewage from our new system of drainage. Unfortunately I have not the sample here, but I will show you later in the day that absolutely no change has taken place although it is now nearly a fortnight old, from which I infer—and, indeed, not only from that, but looking at it from a common-sense point of view, and considering the proportions of the two things, the quantity of the sewage as compared with the volume of the water into which it is discharged—that we have merely in Dublin to pass a clear liquid into the bay when the tide is running out, and we need not trouble ourselves with what quantity of soluble or organic matter is in it. If we put a clear liquid into the bay we will never see that again, and there will be no fermentation, such as would occur if it was discharged into a river in an inland place. The sample, as I have said, has remained absolutely unchanged since it was taken.

13040. (*Chairman.*) Is there any ulva, or seaweed, that grows in Dublin Bay in consequence of the discharge of sewage into it?—Oh, yes, both along the southern and northern coasts, but more especially along the northern coast immense quantities of seaweed grow. Professor Letts has described this in his paper, which you have already had before you, and for the last 20 or 30 years we knew that that was the cause of the stench at low water on these coasts. Professor Hartley and I knew it was not the sewage that was responsible for the smell, but the seaweed when decomposition set in.

13041. Is the seaweed thrown up on the shore?—Yes. The matter is referred to in that paper read nearly 30 years ago, "As for the observation of Colonel Walsh that the sewage caused the smell on the Clontarf foreshore, he believed that that arose from the decomposition of seaweed and not from the sewage"; and that was anticipating Dr. Letts' opinion by a quarter of a century.

13042. Is there much stacking up of the seaweed along the coast?—No, not much at all.

13043. Is there much seaweed brought in and deposited on the shore?—Not a very large quantity.

13044. Is that northern side of the bay protected, and does it offer conditions which would encourage the growth of seaweed?—The worst place for this accumulation of seaweed is at the Clontarf shore on the north side—it is a very shallow part of the bay, and it is very often affected even when the tide is in, and the smell is very offensive there.

13045. Of course I presume the storms cannot drive the water inshore?—Oh, yes, in storms the sea sometimes goes up on the roadway there.

13046. That is at the Clontarf side?—Yes; I have seen the roads flooded with sea water there in times of storm.

13047. Are the walls, which are shown on the map, not sufficient to protect the road from the sea?—The wall that is shown is a work by the Port and Docks Board for the purpose of giving a deep channel, and it has not much effect on the part I speak of.

13048. And there is sufficient water on that part of the coast to enable the storm to throw up the tide?—Yes, I have seen huge waves here. The bay is very wide at that part, and there is a large part of the bay between the lighthouse and Clontarf very much exposed when the winds are in a particular direction.

13049. So that along there the seaweed would get thrown up on the shore?—Yes; and there is a bank being formed there by the action of the water. The place on the map known as the North Bull is a sea-formed bank, which is gradually becoming more and more extensive. When I was a child there was very little sand there at all, but now there is an immense sandy island there with golf links on it. That has taken place within the last half century.

13050. Are any steps taken to dispose of the seaweed thrown up there?—No.

13051. None at all?—No, and I may mention that the shores on the North Bull are extremely filthy in consequence of all the sewage being discharged there on the sand, and in Clontarf Bay there is the same state of things. In the year 1880 I made an examination of oysters grown on beds at Clontarf, and found them swarming with bacteria, and I read a paper on the subject entitled "Typhoid from Oysters" before the British Medical Association at Cambridge, and the chairman said, "I suppose, Dr. Cameron, this is one of your usual jokes?" but the matter is not regarded as a joke now, for an enormous amount of disease is created by the pollution of shell-fish on these shores.

13052. Are these oyster beds still there?—No. The Port and Docks Board refused to renew the licence of the beds where I found these oysters, but there is a bed at another portion of the shore where the bed is raised a considerable distance above the level of the sewage. I think in beds where the sewage goes down to a little above where the oysters are laid there is great danger, but where the oysters are raised on beds considerably above the sewage when the sewage is let down at low water it passes out and does not reach the oysters. That is the position of the beds there now, but in the other cases where the licence would not be renewed, the sewage could reach the oysters. That is the case in many places on the English coast.

13053. Then I take it there are still extensive beds of oysters on the Clontarf shore?—Yes, but other extensive beds have been abolished in consequence of the result of my examination of the oysters. That was the

first time attention was directed to the possibility of typhoid and enteritis being produced by persons eating shell fish from places where sewage had access to. We had a terrible case in Dublin some years ago, but in that case it was mussels, a whole family were poisoned by taking mussels at Salthill on the southern coast from a place where there was a small pool that mussels had access to. It occurred in the family of a well-known journalist, and his wife and children died. I examined some of the shell fish, and I found they contained poisonous matter—the livers were four times the ordinary size, and the shells were as brittle as thin glass.

13054. Does the present drainage of the township of Clontarf simply run out on the shore?—Yes, all along at short distances from the road the contents of the sewers are discharged on the open strand.

13055. It is proposed to take the sewage round by the red line shown on the map to the outfall works of your new system?—Yes, but Mr. Harty, the city engineer, will tell you about the districts that are to be drained.

13056. (*Dr. T. J. Stafford.*) Clontarf has now been annexed by the Corporation of Dublin, and forms part of the city of Dublin?—Yes.

13057. And the township of Clontarf no longer exists as a township?—No. The whole of that township and of Kilmainham and Drumcondra have been annexed to the city with a population of about 25,000.

13058. (*Chairman.*) To return to the question of the seaweed—are any steps taken to clear away the seaweed that is thrown up on the shore?—No, not the slightest.

13059. It is not removed for manure?—Very little of it.

13060. Is it the same here as at Belfast—are large banks of seaweed driven up on the shore by the east wind?—Not to the same extent as at Belfast.

13061. But still there is enough of it to become a nuisance?—Yes, but I think it is worse at Belfast. I know that when I went down with the Army Sanitary Committee of Belfast as to the proposal to make the Episcopal Palace into a barracks, although the situation of the palace was a very long way away from the shore, yet we confessed that the smell was simply awful. Here you don't get the odour unless you get pretty close to the shore. At Belfast on the Co. Down side you get it half a mile away.

13062. Do you think that that has a deleterious influence on the health of the inhabitants?—Well, I have an old-fashioned prejudice against bad smells, and I don't think it can do anyone good, at all events.

13063. Have you anything more to tell us about the present sewage system before we change the subject?—As to the existing system, my objection to it from a medical point of view is that not only is the river polluted and a bad odour emitted from it, but the sewage is detained so long in the sewers that there is danger of the gases and vapours, and perhaps solid particles from it, finding their way into the streets through the ventilating openings. In Dublin, as the City Engineer will explain to you, the sewage is discharged into the river, and the mouths of the sewers are provided with the usual tidal valves, but when the water rises up with the tide the valves close, and the sewage is backed up often to an enormous extent, and if it was not for the pumping station which takes out the surplus sewage at these times the lower parts of the city would be inundated. These engines are now kept constantly going. I need not tell you I don't like to have sewage backed up for eight hours at a time, and often backed up for a quarter of a mile from the mouth of the sewer.

13064. And that is especially so at the neap tide?—Yes; and then there is the storm water to contend with. I may say that a large portion of Dublin has the basement storey a considerable distance below high water—in many cases as much as 6ft. or 8ft.—and it is only the pumping that keeps the basement clear; in fact, but for the pumping the basements in these districts would be flooded at high tide.

13065. Is not the River Liffey in a state that is very deleterious to health?—Yes, it is in a very bad state.

13066. A great number of drains discharge into the river?—Yes, and the volume of sewage has been greatly increased by the increase in the number of water-closets in the city—an increase of about 10,000 in the last 10 or 15 years. All these send their water into the river. I remember when a child fishing off the steps along the quays here. Mullet and other fish were regularly caught along the steps by the river, and men and boys were fishing away all day. The river was perfectly clear, but with the development of the water-closet system of course the river has become more and more polluted, and now the salmon find considerable difficulty in getting up the river, and they keep dodging about waiting for storm water. Sometimes the sewage is very injurious to them, and many dead salmon have been found in the river—that is in very warm weather, when the amount of oxygen is reduced to a low level.

13067. Is it always oxygenated?—No, there are some times when there is practically no oxygen in the river.

13068. Then it becomes a septic tank?—Yes; about one-twelfth of it ought to be oxygenated at low water, but there are times when there is no oxygen at all.

13069. The mud at the bottom of the river is bad?—Yes, that is the real delinquent, and it is when the sides of the river are laid bare that the odour is intolerable, but now even when the tide is half in the whole mass of water becomes offensive, especially in summer.

13070. It is proposed by your new works to prevent that drainage getting into the river, and to carry it out by a pipe to your outfall works?—Yes, it is proposed to collect all the sewage that now passes into the river and to convey it to the outfall works. Of course, pumping is required on account of the low levels of the city, and after treating it the effluent will be discharged into the bay. I believe we may concern ourselves very little about getting the solid matter out of solution—a problem that occupies the attention of people living in inland places—here we have merely to take the solid matter out and we will have no more trouble with the effluent.

13071. What process do you propose to use to take out the solid matter?—I suppose lime would be the principal thing, but, to use a legal phrase, that is a matter that is still *sub judice* at present, for the completion of the works is still two years off. Chemical experiments will be made to determine what proportion of lime will be employed, if we use lime.

13072. That is a matter not yet decided on?—No, it is a matter for consideration—we have never yet been able to deal with an average sample of Dublin sewage. I got as near to it as possible in the results of the 40 analyses, but that was a long time ago, and the water-closets have been multiplied since then.

13073. Is it conceivable that you would use the outfall works merely as a settling tank?—I would be utterly opposed to the septic system in Dublin—I don't see any necessity for it.

13074. You did not catch what I said—not a septic tank, but a settling tank?—Certainly; I hold that if we take the suspended matter out that is all that need be done in Dublin, as we have the open sea before us.

13075. In that case what will you do with the deposit?—That also is still *sub judice.* I am rather inclined to use it for the reclamation of offensive slobs, of which we have an abundance, at convenient places for that purpose.

13076. By depositing it on the slobs?—Yes, and not taking it out to sea.

13077. Have you any machinery for pressing it?—Not yet; but, individually, I am in favour of pressing it and using it in some such way, and not sending it out to sea.

13078. You would be in favour of using it for the reclamation of slob lands, and these exist in the comparative neighbourhood?—Yes; there are plenty of them on the south side of the bay that could not be made more offensive by depositing that sludge upon it.

13079. (*Colonel Harding.*) Can you give us any idea of the volume of the stream of the Liffey—is it considerable?—Yes, it is a very large river, as you can see; but at this moment I cannot tell what quantity of water passes down. I dare say Mr. Harty, the engineer, can tell that.

13080. I gather that in your opinion the foul condition of the Liffey is due in a large part to the sewage being retained during high water by the closed valves in the separate sewers, so that the sewers are like septic tanks on the bank of the stream, which as the tide falls discharge their putrid matter into the river?—Yes, but the fouling is due to the suspended matter, not to the soluble portion; it is due to the dejecta and vegetable matter.

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13081. But the great fouling of the river is due to these matters being retained in the sewers, whereas if they could flow forward as they entered the sewer the putrefaction would not take place until later?—Decidedly.

13082. Do we understand that by the new system of drainage by intercepting sewers there will be a constant flow through the sewers to the pumping station, and that the stagnation will no longer take place?—That is almost the most important of the objects to be attained by the new system.

13083. So that in all probability when the sewage arrives at the outfall works it will not be in a partly putrid condition, but fairly fresh?—It won't be so offensive as if it had been retained for seven or eight hours in situ.

13084. And you consider that its mixture with sea water before putrefaction has been developed will be a great improvement on the present state of things?—Yes, I have no doubt that the soluble organic matter, which makes up in some cases 70 or 80 per cent. of the total organic matter, will give us no further trouble—it would give some trouble if delayed for a long time in the sewers, so that fermentation might be set up and some of the soluble matter might become insoluble.

13085. You think that the trouble at the outfall will be very little if you carry the solid matter out to sea?—Yes; let the solid matter go to sea, and there will be no more trouble.

13086. The suspended matter is to be taken out to sea from the outfall works?—The idea at present is to take it out to sea, unless some other method of treatment is devised before the works are completed.

13087. (*Mr. T. J. Stafford.*) As to your analyses of the sewage discharge from a brewery—that is from Guinness's brewery in the bottle before us?—Yes.

13088. When was that taken?—In the afternoon; they were watching for me in order to have this discharge made.

13089. Were they discharging from the vats when that was taken?—They were.

13090. Have you any samples of distillery sewage?—No, except in the case of the Smithfield sewer, into which a distillery discharges.

13091. But you have no corresponding sample of a distillery sewer to that from Guiness's?—No, not direct from a distillery, but it would be exactly of the same kind. There would be no difference in the nature of the sewage.

13092. It would not differ from the brewery discharge?—No, they must begin with the same process of converting the starch into alcohol, and the residue will be the same in each case. There will be the same washings of the vats as in the brewery. There is one little peculiarity about our sewage—the absence of lime salts and magnesia.

13093. (*Chairman.*) The water here is very soft?—Yes, it has only two degrees of hardness—it only contains 2 grains of lime per gallon; lime comes into the fourth decimal place per gallon.

13094. The water, then, is very soft?—Yes, and practically there are no earthy salts in the sewage at all—they are all alkaline salts and phosphorous.

13095. (*Mr. T. J. Stafford.*) You say you will have no more trouble from the effluent you are going to discharge from the new works into the bay?—Yes. If we send in a clear effluent, no matter how much organic matter there is in it, I think it will give us no more trouble.

13096. Will it give no further trouble in connection with the growth of seaweed on Clontarf shore?—No.

13097. That is not quite the experience in Belfast?—It would discharge into the sea here when the tide is running out, and be carried into the Channel, and so enormously diluted that it will give us no further trouble; what really encourages the seaweed is the suspended matter, it is not the soluble matter.

13098. They have had very considerable difficulty in Belfast in connection with this growth of seaweed?—If the sewage went in, as it will go in here, they would have no trouble.

13099. You know that in Belfast they have had considerable trouble, and they have been obliged to get a very high degree of purification in order to prevent the growth of this seaweed on the foreshore of Belfast?—I did not know they had got it yet.

13100. No, but they are endeavouring at present to get a high degree of purification for that reason?—I don't think it is necessary as far as Dublin is concerned, for it is better situated than Belfast, because Belfast is almost in the position of being on a huge river; it is a long way from the sea, but here we are on a wide bay and close to the Channel, with strong currents. When we have the tide running out, and we have a clear liquid, I am sure we will have no further trouble—it won't be in the slightest degree injurious or contribute to the growth of the seaweed.

13101. (*Chairman.*) You are going to let the sewage escape into the bay within that part marked Crab Lake basin, and if so, it will run into the narrow part of the Channel shown on the map?—Yes, but that is a wider place than it appears to be there.

13102. You say it will be carried out by the tide, and on the return journey you say it is only very diluted sewage that will get into the narrow part?—When the tide returns the quantity of sewage in it will become homœopathic.

13103. And supposing that seaweed is nourished on the solid matter in the sewage, the sewage will be so diluted it will afford no encouragement to the growth of the seaweed?—That is my conviction.

13104. (*Mr. T. J. Stafford.*) And the growth of seaweed on the Clontarf shore is due nearly altogether to the discharge of crude sewage along that part of the coast?—Nearly altogether to the solid matter deposited there.

13105. (*Dr. J. Burn Russell.*) This backing up or deposit of sewage in the sewers that you have spoken of, how far would that extend back into the city?—Of course, it depends on the sewer; in some sewers it extends a long way—in some cases it goes a quarter of a mile up.

13106. Will that state of things be altered when the intercepting sewers are put down?—Yes. The sewage will be continually flowing.

13107. The sewage will be continuously flowing from the street drains to the outfall?—Yes, in fact, they will be in the same position then as they are now when the tide is out. They won't be backed up when the main drainage system is completed, and I think that that is a matter of great importance.

13108. While the sewage is banked up in this way at present there must be a considerable amount of deposit in the sewer?—Yes.

13109. Is that deposit thoroughly swept out?—The sewers are flushed occasionally.

13110. They are artificially flushed?—Yes, occasionally, and sometimes when there are epidemics they are treated with disinfectants. Mr. Harty gets them flushed, and we supply the disinfectants from the Public Health Department. They are artificially flushed, and, of course, the storm waters flush them out, too.

13111. What is the death-rate in Dublin—I suppose there has been a considerable improvement in it in your time?—With regard to zymotic diseases an immense improvement. Our former rate was from 5 to 8 per thousand, but for the last 10 years, taking the metropolitan area, which I hold is the fair thing to take, compared with London and other places where large areas are dealt with——

13112. Would you give us the slum places?—I can give you the registration area—that is, the metropolitan area of Dublin metropolis, in the same way as in London, the registration area is taken, including more than the city.

13113. What is your total death-rate?—Ours is generally about 24 per thousand.

13114. How long has it been so?—For several years past, but our former rate was 30 and over it; but it is the zymotic death-rate that has declined largely.

13115. What are the main contributors to the death-rate?—The main contributors to the death-rate are constitutional diseases—Bright's disease, phthisis, which carries off about 3 per thousand, and a very high death-rate from tuberculosis and diseases of the respiratory organs.

13116. Do you know anything about the level of the ground water in Dublin?—Yes, I published a series of experiments on the ground water of Dublin which dis-

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closed a most curious state of things. Dublin was supposed to be a water-logged city, but I experimented some years ago, and I found that the nearer you approached the river, the deeper was the water, and quite close to the bank of the river it was from 14 to 18 feet from the surface, and when you get up 70 or 80 feet above ordnance datum, the ground water was within 5 or 6 feet of the surface. That is due to the fact that Dublin is situated on two descriptions of soil—one is boulder clay, which is very heavy and retentive, and the other is limestone gravel. The limestone gravel is near the river, as we might expect, consisting mostly of deposits from the river. A most curious thing, on this ground, which is comparatively dry yet near the river, the amount of typhoid is 50 per cent. greater than on the boulder clay.

13117. Does that point to soil pollution?—Yes, it is more easy to pollute gravel than stiff clay, and the conditions under which bacterial life can be developed are more favourable in loose soil, and the facilities for the escape of bacteria from loose soil are greater than in stiff soil.

13118. In the case of these sewers that are banked up by the tide, are the sewers thoroughly water-tight, or do they leak?—The main sewers are really very good, but the cross drains from the houses to the mains were not well constructed formerly—they were not well cemented, and the pipes were not connected properly, and there is immense drainage from them into the soil, which led to considerable pollution. That took place formerly, but it does not take place lately.

13119. So that when the main sewer is banked up there would be some loss from the tributary pipes from the tenements?—There would be, but that is a decreasing quantity every year. There are between 1,500 and 2,000 new pipe drains made every year, and they will remove that state of things ultimately.

13120. Have you analysed any well water or ground water in the neighbourhood of this polluted area?—Yes, I have examined a great many specimens.

13121. Did you find it very much impregnated with sewage?—Very much, there were myriads of micro-organisms.

13122. And you think that that is the habitat of typhoid fever?—Yes, I say to a certain extent it is a soil disease in Dublin. For instance, out of about 10,000 cases I have studied in the last 10 years, I found regularly during that long period of time, there were about 50 per cent. more cases occurred on the area which has a gravel soil, and without any reference to the economic or social position of the persons affected by the disease.

13123. Is that a privy area, or was it ever a petty area?—That is another peculiarity about our city; we have no part of Dublin in which there are not purlieus; you cannot go any direction in the city without coming upon purlieus within 500 yards; they are at the backs of all the fashionable squares.

13124. That is what we call mews lanes in Scotland?—Yes. The people who formerly lived there and had carriages have left these houses, and the stables are converted into residences, and the spaces at the back of the houses have been built on. This has occurred at the back of the fashionable streets, so that all over the city there is a poor population.

13125. It is more scattered amongst the wealthy parts of the city here than in other cities, you think?—Yes, than in London or Edinburgh. You can go miles in London without coming on purlieus, but you cannot do that in Dublin.

13126. And water-closets have been introduced in all these districts?—Yes, there are very few petties remaining; even in the very poorest class tenement houses the water-closets are introduced in the yards.

13127. In the use of these water-closets are you aware what the habits of the people are?—Yes, and I am sorry to say they are not what I would like them to be.

13128. They have sinks, I suppose, in the houses?—Yes.

13129. How do they use them?—That is a difficulty; they are abusing them.

13130. They have these sinks in the houses?—They have slop sinks, and we are trying to introduce a kind of slop sink that will prevent the abuse we complain of.

13131. I particularly refer to the habits of people who have to go to a water-closet in a yard. Are they in the habit of putting night slops down the sink; is that the habit in Dublin?—To a certain extent it is.

13132. So that even in the house the drains would be impregnated with matter?—Yes.

13133. We know that slop excreta is in a much greater state of decomposition than the excreta from a water closet in the ordinary course of use?—Yes; they often keep it for a long time before throwing it out. There is a very general impression that we have a very high zymotic death rate, which is not the fact; it is slightly below the rate in 33 of the largest English towns.

13134. But the question would arise, what sort of zymotic diseases? Have you ever scarlatina?—Yes, and sometimes measles. We have a high typhoid rate, but a moderate diphtheria rate. Our typhoid and diphtheria taken together are slightly less than in London; we have a very moderate diphtheria rate, and that is also looked upon as a disease that depends largely on insanitary conditions.

13135. But if you get a poor population with all sanitary conveniences, and even the water-closets in the yard, won't these habits about the disposal of the bedroom slops inside the house contribute to the typhoid fever?—That is so, but it is a remarkable fact that the social condition of the persons affected by the disease appears to be no factor in the case at all. I have gone into that question, and the disease appears to be most impartial in attacking people in the highest ranks as well as in the lowest.

13136. How do you classify your population; is it on the rental or the size of the house?—On the occupation basis—the professional classes, the upper classes, and general service classes, subdivided again into the different trades, those engaged in textile manufactories, and so on.

13137. And generally you anticipate that the introduction of this system of sewage interception will strike at the root of a good deal of your typhoid fever in Dublin?—I am quite sure it will.

13138. I suppose your water supply is above suspicion?—Yes, it is beyond suspicion. I suggested to the Waterworks Committee to get Professor Percy Frankland to come over here to make a special investigation into the water supply and its source. He came, and after a lengthened investigation he pronounced our supply one of the best in the world.

13139. (*Chairman.*) And it is quite plentiful too?—Yes.

13140. (*Dr. J. Burn Russell.*) Is the scavenging of the back yards in Dublin carried out to your satisfaction?—It is fairly well done, I think.

13141. Do they use water in any quantity to hose out the back courts?—Yes, they do occasionally.

13142. So as to act the part of rain. How about house refuse removal?—I don't think our bins are emptied as frequently as in Edinburgh, but we have the bin system very largely in use in Dublin, and it will soon be the sole method of storing filth until removal.

13143. Does any excremental matter reach these bins?—Yes, very frequently; families in Dublin are supersensitive about being seen going into these closets.

13144. That was what was in my mind, and especially with reference to women and children?—The children, I am sorry to say, generally select the floor of the closet or the surface of the yard for the purpose, and that is one of the greatest troubles we have in Dublin.

13145. But that is a habit that can only prevail in one class of society?—Yes, there is a morbid sense of sensibility on that point among the female population.

13146. So that the upshot of it is that when you speak of the advantage of the water-closet system you want to know where the closets are in order to estimate their exact hygienic value?—Yes. I have invented a kind of closet which is a trapless closet, intended to meet the difficulty we meet at present owing to the improper use of the closets. We get about 200 notifications every week that water-closets are blocked up, notwithstanding which they are continued to be used until they overflow. To meet that I have devised a closet without a trap inside, so that when a block occurs it is out in the trap in the yard, and it is seen at once and the obstruction removed.

13147. Have you much diarrhœa in Dublin?—No, we stand favourably in that respect as compared with

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English towns; our rate from that cause is moderate, which I trace to the moderate summer temperature we have.

13148. Have you had cholera in Dublin?—Yes, we had one epidemic in 1864 or 1865.

13149. What did it do? Did it light on the parts where typhoid prevails?—Yes, it was almost altogether confined to the poor localities, and the number of deaths decreased at each visitation; the first attack carried off about 4,000 persons, and the last about 1,000.

13150. Had you the present Vartry water supply then?—Not at the first visitation; it had just come in during the last visit of cholera to the city, but it was not quite distributed over the town at the time.

13151. And on the last occasion the cholera was remarkably less in its incidence?—Yes, remarkably less.

13152. Your death rate from constitutional diseases, pulmonary disease or phthisis, you say, is heavy?—Yes, we have 50 per cent. above the average of deaths from diseases of the respiratory organs. We have in Dublin an unusually large poor population. I got the percentage taken of the number of dwellings and the number of occupants, and I found that of the 64,000 families living within the city 32,000 occupied 48,000 rooms. I know you are a great authority on the subject of the relation of the number of rooms to the health of the people, and therefore I mention that I found 32,000 families residing in 7,000 houses occupying 48,000 rooms, while the other 32,000 occupied 17,000 houses.

13153. Have you any statistics based on the late census?—Yes; the return is just out, and it carries me a little further, and strengthens my deduction, for I find 30 per cent. of the population occupy only one room for each family.

13154. That has a very serious effect on the physical condition of these people?—Very serious; and the houses are for the most part houses that were occupied in the early times by single families, and now there are sometimes eight families in the one house.

13155. About these oyster beds. I understand you to say there are still some beds on the Clontarf shore?—Yes, but they are considerably above the level of the sewers, and the others which were abolished were below the level of the sewers.

13156. Does the water of the river ever get access to them?—It does at certain states of the tide.

13157. Does that water not contain the elements of sewer pollution?—Quite possibly, but if we went that far we would have no oysters.

13158. Do you mean in Dublin Bay?—No, but generally throughout the United Kingdom. Personally I would not like to eat an oyster from Clontarf, but still it is a great industry, and it is a serious thing to deprive people of their livelihood unless there is great evidence of actual danger, and the beds here are not worse situated than thousands, or perhaps I should say than hundreds, of oyster beds in other parts of the United Kingdom.

13159. Are these beds at Clontarf beds for the production of oysters, or only for deposition?—Not for production, for the deposition of them only.

13160. And where are the oysters produced?—They are generally from the coast of Wexford, but our best oysters are got from the lonely west coasts, where they are free from any danger of contamination from sewage, as they are not near any large population.

13161. Then in the case of the beds at Clontarf, they are put there to fatten on the germs brought down by the sewers?—They do everything there, but I am glad to say they supply the London market largely from Tralee, and other parts of the coast like Tralee away from cities.

13162. (*Chairman.*) Are the Clontarf oysters eaten locally?—They are, but they are generally made into soup.

13163. You have not come across any cases of blood poisoning from the Clontarf oysters?—No, not from Clontarf, but I have from the neighbourhood of Dundalk.

13164. (*Mr. T. J. Stafford.*) That would be from Carlingford Bay?—Yes, and it is believed that it was from Carlingford Bay oysters the present Prince of Wales got his attack of typhoid. That was his own opinion, and the opinion of Sir William Broadbent. I made inquiries, and I found the oysters had come from Carlingford Bay.

13164*. The sewage of Newry goes into that bay?—Yes.

13165. (*Dr. J. Burn Russell.*) Are there other oyster beds in the Liffey?—No; there was formerly a bed at Poolbeg, but it was a long time ago.

13166. (*Mr. T. J. Stafford.*) Your new system of sewage disposal will prevent any pollution of the oyster beds?—Yes, and I hope the whole coast at Clontarf will have oyster beds then.

13167. (*Dr. J. Burn Russell.*) Have you examined any of the oysters here?—Not very frequently, but I have occasionally.

13168. What was the result bacteriologically?—Not very serious. I examined the oysters taken from the shops here, and I also examined some from the Lee River for officers of the Local Government Board. The oysters were from beds that belonged to Mr. Smith Barry, now Lord Barrymore, and I found no trace of bacillus colus communis.

13169. There were no actual cases of poisoning from shell fish brought under your notice except those you have mentioned?—Yes, there was a case which I published in the "British Medical Journal" some years ago—an unmistakable case, where fourteen persons partook of luncheon consisting of oysters, chicken and bacon, and nothing more than that, with vegetables; some did not take the oysters, and others did, and others took only oysters. All that took oysters, with or without chicken and bacon, were seized with severe enteritis. They were all people from England, and one lady was so bad she had to remain for a week at Holyhead. She was ill with terrible choleraic symptoms. These were oysters that came from Carlingford.

13170. But you had nothing originating in your own bay?—No, but I have frequently found unmistakable signs of sewage in cockles taken on this coast, and I have warned the people here over and over again against using cockles without boiling them. I believe myself that a large amount of disease—I don't say typhoid, but enteritis—results from taking shell fish of various kinds, mussels and cockles, which come chiefly from the coast along by Irishtown on the south side of the bay.

13171. It is a place of popular resort?—Yes, along the whole of the coast there is an immense quantity of cockles gathered.

13172. (*Mr. T. J. Stafford.*) How do they get polluted?—By sewage, but not so much latterly. All the Pembroke sewage used to go in on that coast.

13173. Where does the Rathmines and Pembroke main drainage system discharge now?—On the sandy island at the South Wall.

13174. All the sewage from the Rathmines and Pembroke townships is delivered out there?—Yes.

13175. (*Dr. J. Burn Russell.*) I suppose there is this distinction between the injury traceable to oysters and that attributed to cockles—that the injury by oysters happens to people in such circumstances of life that it is likely to attract attention, but in the case of cockles the people are generally of the humbler class and the injury may not be heard of?—Yes.

13176. Therefore the injury resulting from the use of cockles is distributed over a larger class and more difficult to detect?—Yes. I think autumnal diarrhœa is sometimes due to shell fish. A medical authority, as you know, recently attributed 30 per cent. of the enteric cases in Brighton to the use of oysters. I think the subject a very important one, and we have taken a good deal of trouble to warn the people.

13177. You say you have distributed leaflets warning the people against the use of shell fish?—Yes; and in addition we have put up posters cautioning the people against taking shell fish without boiling.

13178. Then you think this pollution of shell fish, so far as it arises from sewage, is attributable to the sea itself being polluted along the shore?—I have no doubt of it.

13179. And you anticipate that the water of Dublin Bay will be made innocuous when your new system of sewerage is introduced?—Yes; I hold that the filtering, while it removes the soluble matter, must remove the microbes, for they are all insoluble—that is, supposing the filtering is enough.

Mr. SPENCER HARTY, C.E., called; and Examined.

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13180. (*Chairman.*) Are you Engineer to the Dublin Corporation?—I am.

13181. Is there any other title you would like to put in, so to speak?—No, thank you.

13182. Would you kindly tell us about the disposition of the sewerage works which are now being erected for the city?—What I propose to do is to give a general description of the entire work proposed. Unfortunately we are not at work yet—we are only building our works; they are still in the course of construction.

13183. You might please give us such a general description as you suggest?—Yes. The map on the wall will enable you to follow without difficulty the different works as I describe them. The Dublin Corporation main drainage works were designed in 1891 to take the sewage of the then outlying districts of Clontarf township, Drumcondra, Clonliffe, and Glasnevin township; the urban district of Grangegorman, and New Kilmainham township, together with the city of Dublin as it then existed, and convey it to Pigeon House to be treated there. Since then these districts, together with comparative small additions of Chapelizod village, the rural district of Crumlin and Donnycarney, were annexed by the Corporation, and the city extended under the Dublin Corporation Act, 1900, and which came into operation on the 15th January, 1901.

At the time the works were designed the Corporation was not the sanitary authority of the outside districts above referred to, and consequently had nothing to say to their internal drainage, the scheme as designed merely enabling the Corporation to take their sewage and drainage into the Corporation system, and so treat it.

Clontarf and Drumcondra townships' sewage was and is to be taken at Ballybough Bridge, where it will be intercepted from the River Tolka, and conveyed by a 3ft. circular brick sewer through Poplar Row, Annesley Place, and North Strand Road to Circular Road at Seville Place, and thence by a 3ft. 9in. circular brick sewer through Amiens Street, Store Street, Beresford Place, Lower Abbey Street, and Marlborough Street to Eden Quay, where it joins the North Quay's main intercepting sewer. This work is all complete.

No special sewer was designed for Grangegorman district, as this district immediately adjoined the old city boundary, and the existing sewers were of sufficient capacity.

Kilmainham district was and is to be drained by two systems of sewers—the one which follows the line of the Camac River, a 3ft. circular sewer, to Old Kilmainham Road, where it joins a 3ft. 3in. by 2ft. egg-shaped sewer; and the other, a 3ft. 9in. by 2ft. sewer, goes through the Great Southern and Western Railway grounds at Kingsbridge, and thence along the bed of the Liffey to Hospital Lane, at Island Bridge. It was necessary to have two lines of sewers for these districts, as two separate valleys or drainage districts had to be dealt with. They are the Liffey Valley, and the other may be called the Camac.

The internal main drainage of the city is dealt with by two main intercepting sewers, one on the northern quays and the other on the southern.

The northern main intercepting sewer commences at Infirmary Road, with an 18 inch diameter pipe sewer, which is continued to Albert Quay at Temple Street West, thence by a 3ft. diameter sewer along Albert Quay, Sarsfield Quay, Ellis Quay, Arran Quay, King's Inns Quay, and Upper Ormond Quay, to Arran Street East, and from thence continued by a 3ft. 9in. diameter sewer for remainder of Upper Ormond Quay, Lower Ormond Quay, Bachelor's Walk, and Eden Quay, to Marlborough Street, where it enters the siphon which is carried under the Liffey to the southern side, where it joins that main intercepting sewer.

The southern main intercepting sewer commences on Victoria Quay at King's Bridge by a 3ft. 6in. diameter sewer, and which is continued along Victoria Quay, Usher's Island, Usher's Quay, and Merchant's Quay, to Wood Quay, where it is increased to a 4ft. 6in. diameter sewer, and which is continued along Wood Quay, Essex Quay, Wellington Quay, Crampton Quay, Aston's Quay, and Burgh Quay, to the siphon, where both north and south sewers join. From thence the sewer is continued by an 8ft. circular sewer through Hawkins Street, Townsend Street, Hanover Street, Clarence Street, to Great Brunswick Street, where it changes from brick to cast-iron, lined with concrete. This sewer passes along Great Brunswick Street, under the canal, along Ringsend Road, under the Dodder River, along Bridge Street, Caroline Road, and through made ground to a field south of Pigeon House Road, close to coast-guard station. The sewage is there lifted, and continued from thence by an 8ft. diameter concrete sewer to the outfall works in Pigeon House Harbour.

All the old sewers, which at present discharge into the Liffey, pass over the main intercepting sewers on the quays, and are connected by short lengths of pipe sewer large enough to take the sewage proper and rainfall equal to one-quarter of an inch in twenty-four hours. If the flow in the sewers exceeds this rate the storm water will pass over a weir into the river by the old outlet, which is protected from the flow of the river by a tidal flap fixed on the outside of the quay walls; it will also be protected by an inner flap, which can be examined daily, and which will provide a double security against the river water getting into the main outfall intercepting sewer.

At present the connections between the old city sewers and the main intercepting sewers are temporarily built off by timber shutters, which will easily be removed when the system is put into operation.

The Poddle River district is drained by two branch sewers both delivering into the South Quay intercepting sewer. The larger of these is 3ft. by 2ft., brick and concrete sewer, commencing in Patrick Street at Deane Street, and continuing thence through Patrick Street, Nicholas Street, Michael's Hill, and Winetavern Street, to the intercepting sewer on the quay. The greater portion of this sewer was carried out in tunnel. The smaller one, which is only a pipe sewer, starts at the junction of Great and Little Ship Streets, and runs through the Lower Castle Yard, Palace Street, Dame Street, Sycamore Street, Essex Street, and Eustace Street, to its junction with the main intercepting sewer, the object being to divert all sewage from the Poddle River, and which will be allowed to flow on as usual to the Liffey.

The siphon under the river is constructed of cast-iron pipes 4ft. 4in. diameter, lined with blue bricks finishing to a diameter of 3ft. 4in. It is carried through solid rock at a depth of 21 feet under the bed of the river (taken in the centre of the stream), the bottom of catch-pit being 50 feet below the quay road level at Burgh Quay. The length of 200 feet horizontally from centre to centre has a fall of 6 inches for constructional purposes. The descending leg is reduced by a proper taper pipe from 4ft. 6in. to 3ft. 4in., and the rising leg is also 3ft. 4in. in diameter, so that the same velocity should be maintained in the whole course.

The entire length of the 8ft. sewer from Burgh Quay to Clarence Street at Great Brunswick Street is being carried out in tunnel, there being nine shafts in the streets on the entire length. From Clarence Street at Great Brunswick Street to the pumping station the work is being carried out by the Greathead shield process. The pressure in the air-lock chamber is only about 8lbs. Difficulties have been met with in consequence of the sewer passing through loosely filled in or made ground at Pigeon House Road end, and which was formerly covered by the sea—the air escaping on to the surface of the land.

At the pumping station there will be four main pumps fixed at the station on Pigeon House Road, each to lift 15 million gallons per 24 hours, the lift being 23 feet; three being kept constantly at work and one in reserve. There will be two small pumps to lift 5 per cent. of the dry weather flow of sewage to mix with the lime in order to make lime water—one, of course, as is usual acting as reserve. The total of the working capacity of the three large, and one small pump, will be 46,107,000 gallons per day—equal to 5.123 cubic feet per minute, but if the stand-by plant had to be utilised and put into work the entire would be capable of dealing with 62,214,000 gallons per diem, or 6,912 cubic feet per minute.

A screen chamber with screens or filth hoists in duplicate will be inserted at the junction of the low level sewer and the pump wells. This screen will be made of half-inch iron bars with one inch pitch.

There are in all eighteen precipitation tanks, each being 94 feet square. Of these six will always be in

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full work, three being cleared daily, and nine out of use, being kept for storm-water emergencies and storage.

The average dry weather flow is calculated at	1,640 cub. feet per minute.	
Maximum	2,460 ,,	,,
Maximum wet weather flow	5,010 ,,	,,

The tanks are designed on the assumption that the maximum flow is double the average flow—thus, 1,640 cubic feet per minute multiplied by 2 to get the double, equals 3,280 cubic feet per minute, and allowing for two hours comparative rest, then: 3,280 by 120 minutes equals 393,600 cubic feet, which is the amount which the six working tanks should be and are designed to hold.

One tank to level or crest of weir holds 65,744 cubic feet, and as six are working, 65,744 multiplied by 6 equals 3,280 cubic feet per minute, and allowing for two hours comparative rest, then: 3,280 by 120 minutes equals 393,600 cubic feet, which is the amount which the six working tanks should be and are designed to hold.

It is estimated that the quantity of wet sludge to be provided for will be 350 tons daily, and in addition to that on its first deposit in the tanks 175 tons daily of liquor, which will be separated and pumped back to the tanks.

This total of 525 tons of sludge and sludge liquor requires provision of 18,846 cubic feet.

Contents of one tank up to draw off level equals 6,350 cubic feet, and if this sludge is drawn off three tanks daily: 6,350 multiplied by 3 equals 19,050 cubic feet, so that the quantity is amply provided for in the design of the tanks.

"The tanks have been designed with both longitudinal and cross falls in the floors, the steepest inclination being 1 in 63, taken diagonally, which will enable the sludge to be easily and readily swept off.

"The prism formed by these slopes contains the exact amount of sludge and liquor which will be precipitated from the sewage in two days, the time which each tank will work before being shut off and emptied for drawing off purposes.

"The duration of comparative rest of sewage in the tanks with average dry weather flow will be four hours, and under no circumstances will this time be ever less than two hours.

"The effluent weirs are designed the full width of each tank—six working tanks giving a length of weir of 540 feet. The effect of this will be to reduce the depth of effluent passing over the weir to three-quarters of an inch, so that the effluent will become thoroughly aerated.

"Two lines of floating scum boards will be placed in each tank, in order to prevent any scum that might rise to the surface being blown over in stormy weather.

"The sludge is to be swept from the tanks into a culvert which is being constructed under the inlet channel from one end of the works to the other, from which the sludge will be pumped to the high level sludge tank: the sludge ships being served from this tank.

"The sludge culvert, together with the low level sludge pit and high level sludge tank, will store eight day's sludge to provide against periods when the sludge vessel cannot go to sea in consequence of stress of weather.

COST OF WORKS.

	£.
Contract No. 1, which includes main intercepting sewers on South side of River Liffey to Burgh Quay, Kilmainham, and Island Bridge branches, and Poddle branches	36,227
Contract No. 2, which includes main intercepting sewer on North side, and Drumcondra and Clontarf branches	26,324
Contract No. 3, Liffey siphon and low level outfall	136,000
Contract No. 4, high level outfall sewer, precipitation tanks, and other outfall works	121,000
Contracts Nos. 5 and 6, engines and boilers	15,634
Purchase of Pigeon House	65,000
Buildings, chemical mixing machinery, and sludge vessel, estimated	38,449
Other expenses in connection with present system, and engineering expenses, &c.	44,553
	£. 483,187

That is a description of the works as they are designed.

13184. Then I understand from you that the plan proposed to be adopted is to mix the sewage with lime?—That at present is the plan, but it has not yet been decided whether that will continue. That was the original plan.

13185. I presume experiments were made with lime before you adopted that system?—No, we made no experiments, we are taking what was done in Barking and other places as our guide.

13186. I see that you are making arrangements to remove the sludge out to sea?—Yes.

13187. Sir Charles Cameron suggested that it might be deposited on slob lands for the purpose of reclamation?—We have about 58 acres of slob land at present which is the property of the Corporation, and some of it could be utilised in that way, but at present we are proposing to take the sludge six miles out to sea.

13188. Are you making arrangements to press the sludge?—No, we don't think it necessary.

13189. Can you tell us as to the nature of the currents in the neighbourhood of the outfall works?—Yes, there is no question at all but that some of the effluent will absolutely go out to sea and at other times some may not.

13190. Are you going to allow the tank liquor to flow during all states of the tide?—Yes, at all states of the tide.

13191. Would it be possible to have tank accommodation to store it up and only to let it out on the ebb tide?—In consequence of it being purified we do not propose that at all.

13192. Could you give us any idea of the flow of the tide?—Mr. Griffith, of the Port and Docks Board, gave evidence as to that before the Joint Select Committee of the House of Lords and the House of Commons on the Dublin Corporation Bill in the Session of 1900. He made several experiments at all times of the tide with floats, and he found that a great portion of the sewage went out to sea between the two lighthouses, but at other times the floats were all carried over to Clontarf.

13193. Which would imply that at certain times the effluent would be carried over there?—Yes, and at present the crude sewage from the Pembroke and Rathmines main drainage is carried over there. It is flowing at certain times of the tide, but that is not sufficient to take it away, and these two township boards pay the Port and Docks Board £265 a year for dredging. I will read the evidence given by Mr. Griffith as engineer for the Port and Docks Board on this subject before the Select Parliamentary Committee.

Evidence taken before the Joint Select Committee of the House of Lords and the House of Commons, Dublin Corporation Bill, Session 1900. Mr. John P. Griffith, sworn. Examined by Mr. Bushe.

"You were originally a witness in this case against the Corporation on behalf of the Port and Docks Board when they had a petition before the House of Commons?—Yes, last year.

"And as far as their petition went they succeeded?—Yes, it was with regard to the inclusion of a portion of the estuary the Board opposed.

"(*Chairman.*) The inclusion within the boundary?—Yes.

"(*Mr. Bushe.*) Then when it came before the House of Lords you had no occasion to be present on behalf of the Port and Docks Board?—No, there were clauses agreed to.

"But you were summoned as a witness under the order of their Lordships' House?—I was in May this year, and am this year, at least, by the Speaker's order.

"An issue has arisen with regard to the state of dredging and the condition of sewage on Dublin, and I want to get a few facts from you. In the first place, have you been the chief engineer to the Port of Dublin for 25 or more years?—Assistant and chief engineer, assistant for most of it; I have only been chief engineer for a little over a year.

"Have the Port and Docks Board of Dublin the care and management of the Port of Dublin?—They have.

"And the port extends not merely to the Liffey and the estuary, but considerably outside those two walls—North Bull Wall and Poolbeg?—Beyond those walls this chart will explain the limits of the Board's jurisdiction extending out to a line in the bay.

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"Of course, the Port and Docks Board have a lively interest in everything connected with the estuary of Dublin?—They have from a navigation point of view.

"Do you remember when this Rathmines and Pembroke scheme was contemplated that you naturally were parties to protect your rights?—We sought clauses to protect the port, as we have in every main drainage scheme that has been proposed or passed through Parliament.

"Do you remember when this outfall was created by them?—I do.

"At first I think they went under terms to pay your Board an annual sum to dredge the filth which they might bring down?—That was proposed.

"I should rather say to pay your Board the cost of dredging?—That was proposed, but it was eventually settled that a fixed sum should be charged to have it disposed of.

"And is that a fixed sum of £263?—£265 is the present sum. It began by being £250, but the district was increased by the inclusion of Milltown and the amount was increased by £15.

"You do a great deal of dredging, I believe, in the harbour of Dublin?—Yes.

"Taking first from Poolbeg Lighthouse right up to the city, I think you have dredged many millions of tons there in your time?—We are dredging about 1,000,000 tons a year at present inside the lighthouse—from Poolbeg up to the city.

"In that reach it would cover the dredging in respect of this outfall?—Certainly, anything deposited in the channel.

"When you were bound by your statutory agreement—something has been said about complaints—you had no option except to do the dredging and enforce the payment of the £265?—That is what we have done.

"But I think your attention being called to it in the year 1884, you read a paper before the Congress of the Sanitary Institute?—Yes.

"I will ask you whether this expresses the opinion you arrived at after several years' experience: 'We have now, however, had several years' experience of the actual working of the Rathmines and Pembroke main drainage system, and the results prove the truth of the prediction that this scheme would result in the pollution of the lower reach of the River Liffey, and that a great portion of the sewage would never get out to sea, but be carried by the flood tide on to the Clontarf strand. The experience of the past summer seems to me to put this beyond the region of doubt, and so thoroughly impressed am I of the injurious character of the pollution caused by this outfall that I believe no scheme will satisfy the conditions laid down by the Royal Commission' (that is the Commission of 1879)?—Yes, Sir Robert Rawlinson's Commission.

"Unless it deals with the drainage of Rathmines and Pembroke and intercepts the sewage at present discharged at the Whitebank outfall, and thus free the river and harbour of Dublin from pollution.' When we are told that there were no complaints in addition to that expression of opinion of yours in 1884, do you remember when the Army Medical Committee came over in 1892 and required exactly the same thing?—They did—at least they recommended it.

"You yourself, I believe, made experiments in the neighbourhood of the outfall to see what was the truth about what happened and what came down in this sewer?—We have made experiments in connection with every proposed outfall in the interest of the port to determine whether the outfalls should be permitted or what clauses should be inserted for the protection of the port.

"Naturally. Will you explain to the Committee a certain experiment which you made with floats, and the results of it?—Do you mean with regard to the Pembroke drainage?

"Yes?—Those were experiments at the time the outfall was proposed. We made a very complete series of experiments at that time, embracing the spring tides and the neaps, and the conclusion the port authorities came to was that a portion of this sewage would get out to sea, and a very considerable portion would not get out to sea; that is what is discharged on the neap tides. We have that very varied range of tides at Dublin at spring tides a range of 14 feet; at neaps only feet, and you can readily understand the velocity then at the entrance of the harbour fluctuates very materially.

"I think this is what you said before: "At quick-running springs the floats went straight away out to the eastward, clearing the part entirely, otherwise they went out to the entrance and returned—that is, did not reach the entrance; it is entirely a question of the range of the tide. Such experiments you have to make continually, say, for a month, through spring tides and neaps, through ebb tide and flood, if you mean to arrive at the truth, and we carried out these experiments on that principle not only for that outfall but for every outfall?—Yes.

"Did you find in no less than 12 cases that the floats did not get out of the harbour at all?—It is hardly worth while taking up time by details of that kind, but the general point I wished to impress upon them was that the question of the discharge from these outfalls greatly depends on the range of the tide; the time at which it discharges, and other things which have to be taken into account, and when the port board agreed to the outfall of Pembroke they did it with their eyes perfectly open that a considerable deposit would take place in the estuary, but they considered that in the interests of the townships it would not be a fair thing to oppose the Bill to the death, and they compromised matters, and merely regarding it from the harbour point of view, agreed to accept a certain sum per annum for dredging purposes.

"You expressed the view last year, and you will adhere to it, that you are decidedly desirous of getting rid of that as a crude sewage outfall?—We are. We have gone the length of agreeing a clause.

(*Mr. Bushe.*) In fact there is an agreed clause in the Bill that if this is carried out they will give up the £265 a year which they are receiving.

(*Chairman.*) I presume from that you think that it costs you £265 to remove the sewage which is deposited?

"(*Witness.*) It is more the detritus which affects us—the deposit.

"And you think it costs you as much as that to remove what is deposited?—I am satisfied it costs us more, because it is a fine detritus which we meet down below. We are dredging entirely with sand pump dredges now, and this fine stuff will not deposit in the harbours; it passes through the pump and flows over the side of the vessels.

"(*Mr. Bushe.*) You put it in this way—the sludge does not drift, it settles. Of course I do not mean to say liquid sewage does not go?—I think that refers to a different question. The sewage deposited in the city we have to dredge means quantities of sewage sludge, but not at the entrance to the port; that does not come under the £265.

"It has been suggested over and over again here and elsewhere that the sewage which you see by Poolbeg, which Mr. Melliss spoke about, is really Dublin sludge. I want you to trace the history shortly of the Dublin sewage. A quantity of the sewers, as we all know, discharge at present crude sewage into the Liffey; there is no doubt about that?—The Liffey within the city is practically a great cesspool in which the sewage sludge lies.

"I want you to show where it comes to, and what is done with it, and what becomes of it. I think you told us on the last occasion that it is brought down to the region of the Alexandra Basin. This is your evidence: 'We have to dredge it'?—I think the question divides itself into two points, and perhaps I had better explain to the Committee. The sewage sludge deposits in the river. Of course, the liquid sewage—that is the sewage which is in solution—is carried down the river, but as a matter of fact in our dredging operations we only meet the sewage sludge practically as far as the letter 'E' in the word 'river.' That, I take it, is because our deep dredging terminates there, and we have got practically a settling tank. That you may consider the inner harbour where large draught vessels lie, and the bottom of that inner harbour is a sewage bed you may say, which we are dredging, roughly speaking, at the rate of something like 100,000 tons of sludge per annum. Until late years we have not met sewage sludge in the bed of the channel below that point 'E.'

"You stated on the last occasion that that region you have indicated, the Alexandra Basin, is what you call the great settling tank of Dublin?—Yes.

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"And you said you had dredged in that neighbourhood, and by the time you had got to the letter 'V' the sewage had all settled?—Yes, from 'V' to 'E.' I should rather extend it down to 'E,' because we have extended the deep dredging, and it follows the deep dredging.

"Now, taking the final letter 'R,' it was in reference to that letter you said this 'between the letter 'R' and the mouth of the harbour is practically the clean bed'?—It is practically the clean bed.

"'The fact is our deepest dredging, as it were, arrests the sludge; we come into comparatively shallow water about the letter 'E,' and there a bank stops the mud'?—Yes.

"Is the result of that that until the Rathmines and Pembroke outfall came there was no sludge south of the final 'R' in 'river'?—I think I may say so—east, not south.

"And you put that so clearly the last time you said this: 'Just below the 'Y' we used to dredge perfectly clean builder's sand?—Yes, a little further down.

"But you added: 'But at present out in the channel we find a considerable deposit of mud'?—That is true.

"Did you say that you now have to deal since this several years experience, and from that on, with the considerable deposit which you attribute to what is brought down by the sewer?—We have.

"And that where that deposit now is before had been hard clean sand?—Yes.

"As a man of common sense have you any doubt whatsoever that this sludge is attributable to this outfall?—I have no doubt it is due to the Rathmines and Pembroke outfall, but I should not like to be misunderstood by the Committee. The pollution of the estuary and the slobland is due undoubtedly to all these sewers, Rathmines, city and Clontarf. You have got the liquid sewage flowing over that whole area.

"It is quite true the city had been a great offender, and has brought sludge down to the Alexandra Basin?—Yes. May I explain this chart to the Committee? This shows the strand at low water, the incoming tide flows over it, and brings whatever there is on to it. (*The Witness explains the chart to the Committee.*)

"(*Chairman.*) Whereabouts is it that you consider you have to spend more than £265 in dredging out what has come down through the Rathmines and Pembroke sewers?—Over *that* portion.

"Just north of the wall?—That shallow piece *there.*

"Just north of the wall between Poolbeg Lighthouse and Pigeon House Fort?—Yes, and between that and the channel."

"(*Mr. Bushe.*) My friends have suggested several times that the foreshore is rather clean there, and does not show traces of sewage. What have you got to say to that?—The foreshore is abnormally clean close to the wall, partly because it is a degrading foreshore due to the wash of the steamers, and to the westward of the outfall a curious replacement of the sand takes place—it is blown over from the White Bank.

"That Poolbeg is a very low wall, is it not?—Quite low, the White Bank is that bank standing out to the southward of the wall; it is degrading very fast, and a great deal of that sand is sand which is blown over by the wind. From that sand you can see fishermen dragging their salmon nets.

"Has this thing about finding some fresh sand on the top in any way interfered with your conclusions as to the condition of the outfall?—No, I think when you have 60,000 people discharging their crude sewage into there it would be much better to be without it.

"And I have quoted your opinion that no scheme would satisfy your conditions unless it deals with the drainage of Rathmines and Pembroke?—Yes.

"Are you still of that opinion?—I am.

"And, as you have said, your board are prepared to give up this money if it is done?—Yes, that is provided for in the 64th Section."

Examination of witness continued by Colonel HARDING.

13194. How does the sewage from Rathmines and Pembroke townships get into what is called on the map Crab Lake Basin?—They discharge their sewage within the enclosed water in that basin.

13195. Their sewage is discharged within the enclosed water?—Yes.

13196. You say the effect of your pumping arrangement for your sewage will be to cause a constant stream through your intercepting sewer, and prevent the sewer being banked up by the tide?—Yes.

13197. That you say is a very important feature?—Yes, for at present practically all our sewers are tide locked, and simply sewers of deposit.

13198. The sewage has time to putrify in the sewer?—Yes.

13199. And you think what is proposed would be a great advance on the present state of things?—Yes, and it would be a very important change.

13200. The area of the tanks you are providing necessarily involves some chemical precipitation?—Yes. The space for tanks is limited, but the tanks are designed on the most recent system.

13201. But from their area you will be compelled to have either one or other assisted precipitation system?—Yes.

13202. (*Chairman.*) You reckon on an average three hours stay in the tanks?—The sewage will remain for three hours before being cleaned out.

13203. (*Colonel Harding.*) I understood that the average stay was eight hours?—No, that is the comparative rest from one side to the other.

13204. What is the normal flow of your sewage that goes to the works?—45,000,000 a day is the maximum wet weather flow in the 24 hours.

13205. What will be the dry weather flow?—2,460 cubic feet, at the rate of maximum flow, and 9,000 times that will be the number of gallons—about 22,000,000 gallons a day.

13206. What will be the total capacity of the tanks?—They will hold 1,183,392 cubic feet or 7,384,366 gallons.

13207. Therefore taking 7,000,000 as the capacity of the tanks, they represent about one-third of the amount of the normal flow?—Yes, with 8 hours' stay.

13208. You don't propose to use all the tanks at once?—No, we will use six at a time.

13209. To get adequate precipitation in tanks of that capacity you are bound to have some sort of chemical assistance?—Yes.

13210. You don't anticipate any difficulty from the dissolved impurities in your effluent?—No.

13211. (*Dr. J. Burn Russell.*) I see in the ordnance map close to your outfall there is an oyster bed marked—is that oyster bed still existing?—There is no oyster bed there that I know of.

13212. There is another oyster bed marked nearer the Clontarf shore?—I know there was one there, but I think Sir Charles Cameron got that removed. I heard him say there is another there, and I am surprised at that for I did not know of it. There was one right opposite the outfall in former years.

13213. Then at this moment there is a large main sewer from these townships discharging inside the breakwater in this bay?—Yes, there is one on the south and another on the north.

13214. But the one on the north will be absorbed by the new system?—Yes.

13215. But the other one will still go on?—Yes, but there was a recommendation by the Joint Committee of the Lords and Commons that their system should be joined with ours, and a joint board formed to deal with both.

13216. (*Mr. T. J. Stafford.*) Do the Rathmines and Pembroke townships treat their sewage?—No.

13217. Then it is crude sewage that is discharged there?—Yes.

13218. And it finds its way to Clontarf?—Yes.

13219. It follows the same line as your sewage?—Yes, and, strange to say, ours is to a great extent a deposit on the bottom of the river.

13220-21. And their sewage will probably do very much the same thing?—I would say it would.

Dr. W. E. ADENEY, called; and Examined.

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13222. (*Chairman.*) You have already given us evidence in London on a totally different subject, and we want to know your experience and views as regards the Dublin sewage question—you have already sent in a memorandum on the pollution of the waters of the estuary of the Liffey, which is to be incorporated as part of your evidence?—Yes. (The following is the memorandum referred to):—

"MEMORANDUM on the Pollution of the Waters of the Estuary of the Liffey; a study of sewage disposal.

It is well known that practically the whole of the sewage of Dublin, which includes a population of about 260,000 persons, is discharged in a crude state into the rivers Liffey and Tolka, immediately above the estuary; and it has been found that all the heavier solid matters, and most of the lighter ones, are deposited along the beds of the portions of the rivers referred to, and along the upper reaches of the estuary itself.

"Hence these portions of the two rivers may be regarded for the purpose of practical study as constituting large mechanical subsidence tanks, in which the solids of the Dublin sewage are deposited, with the result that the waters of the estuary immediately below receive the liquid portions only of the Dublin sewage, and the distribution and polluting effect of those matters may be ascertained by careful chemical examination.

"It must be noted that the lower portion of the estuary receives, in addition to the Dublin sewage, the drainage from the two townships of Rathmines and Pembroke, with an aggregate population of some 60,000 people. The sewage from these townships is discharged during the first five hours of the ebb tide from a joint main drainage outfall, situated on the south side of the estuary, and about one mile above its mouth. The character of this sewage is quite exceptional in several particulars. As discharged from the outfall, it carries no road detritus or other heavy solid matters common to town sewage, these being previously separated by means of catch-pits built within the main sewer systems. It may be described as pure domestic sewage very largely diluted with surface, subsoil, and brackish waters.

"The analyses of 72 samples of both the bottom and surface waters of the estuary, together with the particulars of a careful engineering investigation, have been recorded in a joint paper by Mr. W. K. Parry, M.Inst. C.E., and the writer, which was read and discussed before the Institution of Civil Engineers, London, in November last, and has since been published in the Proceedings of the Institution (Vol. 147, 1901-2, Part 1).

"The samples were collected at different states of the tide, and at different tidal seasons, under different weather conditions, viz., calm and dry, calm and wet, and stormy.

"The aeration method of analysis was employed in their examination. This method was described before the Commission by the writer, when giving evidence on a previous occasion.

"As was to be anticipated, the waters of the estuary were found to be most polluted at low spring tides, when the volume of sea water lying in it is at a minimum. The distribution of the polluting matters, and the degree of pollution, at such times are well shown by the subjoined table of results of analyses of samples collected under calm and dry weather conditions along the deep water channel, opposite the old Pigeon House Harbour and downwards, from both the surface and bottom at a depth of 14 feet. The samples were preserved for four to five days after collection out of contact with the air before analysis:—

	Bottom Samples.				Surface Samples.			
	No.	CO_2.	N_2.	O_2 in per cent. of Saturation.	No.	CO_2.	N_2.	O_2 in per cent. of Saturation.
Opposite the harbour - -	15	51·3	14·3	86·4	16	72·6	16·5	9·9
1,122 yards below - - -	8	51·4	14·3	91·9	9	62·1	15·5	60·7
1,870 „ „ - - -	13	51·0	14·3	93·3	14	56·0	14·8	89·6

"It is quite evident from these figures that the pollution by the Dublin sewage matters is practically confined to the surface waters of the estuary, the bottom waters being, at least along its less shallow portions, but very slightly affected. This is the more instructive and interesting when it is remembered that the old Pigeon House Harbour is some two miles below the outfalls of the principal Dublin sewers.

"It is quite possible to approximately estimate the proportion of mixed river water and sewage to sea water in each sample from the total solids taking those of the river water and sewage at 50 parts, and those of the sea water at 3.655 parts, per 100,000 thus:—

Bottom Samples.			Surface Samples.		
Number of Sample.	Total Solids.	Proportion of river water to sea water.	Number of Sample.	Total Solids.	Proportion of river water to sea water.
15	3,098	1 : 5	16	929	3 : 1
8	3,169	1 : 6·4	9	1,829	1 : 1
13	3,151	1 : 6	14	2,602	1 : 2·4

"Having thus found that the pollution of the estuary under the most unfavourable conditions is confined to the surface waters, and is in them well within the limits of fouling (see sample 16 in first table), it was not surprising to find that the pollution under the most favourable conditions—that is, at high water—is hardly appreciable. Thus a sample collected opposite the harbour at high tide on a calm day showed a loss of aeration amounting to 2·1 per cent. 24 hours after it had been collected.

"Much interest attaches to the condition of the estuary waters at low water of neap tides, when the transport action of the tide is at a minimum, and when

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it was believed a good deal of sewage remained within the estuary, and was carried on to the foreshore of Clontarf by the ensuing flood tide, especially when the wind was blowing from the south-east.

"A careful examination of the waters at neap tides was consequently made. The general results obtained are indicated by the particulars given in the following table. The samples were all collected from the surface and were kept for 10 to 12 days out of contact with the air before analysis:—

Sample No.	Where Collected.	When Collected.	Carbon Dioxide.	Nitrogen.	Degree of Pollution.[1]	Total Solids.	Ratio of River Water to Sea Water.
	Deep-water Channel.						
18	1,930 yards below Pigeon House Harbour	At low water	60·0	14.5	18·4	2,709	1 : 2·9
28	1,450 " " " " "	70 minutes later	58·7	14·4	22·5	2,826	1 : 3·4
	Shallow Water, South of Deep-water Channel.						
17	1,930 yards below Pigeon House Harbour	At low water	69·1	15·8	40·5	2,096	1 : 1·3
27	1,450 " " " " "	70 minutes later	68·7	15·6	38·2	2,001	1 : 1·2
	Mouth of Harbour.						
19	North side of channel	Just at the turn of the tide	53·8	13·9	13·0	3,150	1 : 6·0
20	Mid-channel		58·0	14·5	20·9	2,926	1 : 4·0
21	South side of channel		54·5	13·9	17·3	3,166	1 : 6·3
23	North side of channel	30 minutes later	53·4	13·9	12·8	3,266	1 : 8·3
25	Mid-channel		56·7	14·3	18·9	2,997	1 : 4·5
26	South side of channel		54·7	14·0	21·9	3,213	1 : 7·3
	Outside Harbour.						
22	North side of channel	30 minutes after low water	49·8	13·6	7·7	3,402	1 : 14·0
24	" " "	20 minutes later	48·8	13·5	8·9	3,475	1 : 20·0
	Shallow Water, North of Channel.						
32*	Opposite Pigeon House Harbour	Half flood	48·11	12·52	1·70	3,469	1 : 20·0
33*	" " " "	Low water	51·9	12·57	21·7	3,328	1 : 10·0

* These analyses figures are not quite comparable with the preceding ones, as they represent the condition of things at different tidal seasons—No. 32, those obtaining at half flood spring tide, and No. 33, those at low water average tide, and they were collected the year previously (1899). No. 32 was kept 28 hours and No. 33 seven days after collection and before analysis.

(1) The analysis figures in this column indicate the per cent. loss of dissolved oxygen in the samples, after keeping them for noted periods of time, the maximum quantity of oxygen which the samples could hold in solution in an unpolluted condition being taken as one-half that of the nitrogen they contained.

"It will be observed from the foregoing table that at low water of neap tides, under calm weather conditions, the tendency of the polluted water is to lie over on the south side of the Channel and not on the Clontarf side. Possibly the tendency would be towards the Clontarf side with south-east winds; but even then it is evident that the pollution must be very slight, and must rapidly become inappreciable as the pure sea water from the bay flows in with the flood tide.

"In very wet weather the estuary becomes discoloured and looks bad, especially at points where floating matters accumulate. The discolouring matters, however, are due to finely-divided mineral substances, large quantities of which are discharged into the estuary through the Dublin and townships' sewers.

"Having briefly indicated the distribution of the sewage matters through the estuary waters at low tides, it may be of interest to make a few remarks in explanation of how the sewage matters are finally disposed of. Are they lost in the great bulk of sea water in the estuary, remaining there and undergoing purification under the influence of bacterial fermentations and higher vegetable life? or are they transported out of the estuary by tidal action? or are both these actions at work to keep the estuary waters in the comparatively pure state in which they are, and to prevent the filth daily poured into them from gradually accumulating and fouling them?

"It is doubtful, having regard to the analytical data obtained, whether much purification of the liquid sewage matters by bacterial action occurs within the estuary. By far the larger portion of them is undoubtedly disposed of by transport by tidal action to the open sea, there to undergo slow but complete purification.

"It is true the analyses show that a considerable quantity of liquid sewage matters remain within the estuary at low water, especially at neap tides; but they show equally clearly that in calm weather these are confined to the surface water, and in stormy weather become so enormously diluted as to be practically undetectable. But in either case they become mixed with the waters of the ensuing flood tides, and are carried out to sea during the next ebb tide, so that so far as the liquid matters are concerned, the estuary is washed out at every tide by pure sea water. That this is the case is due, of course, to the true tidal currents in Dublin Bay and the Liffey estuary; hence the absence of any tendency to the accumulation of liquid polluting matter in the estuary.

"A valuable pratical lesson may, in the opinion of the writer, be learned from a study of the present condition of the estuary. Owing to its configuration and to the tidal currents which obtain in it, it presents quite exceptional natural facilities for the disposal of very large volumes of sewage after the solid matters have been separated by the simplest possible treatment, viz., by mechanical subsidence and screening."

13223. You have had to do with the disposal of the Rathmines and Pembroke sewage?—Yes, I was asked by the joint main drainage board for the Rathmines and Pembroke townships to thoroughly examine the condition of the estuary waters, with the view of giving some explanation before the Parliamentary Committee, which took evidence on the Dublin Annexation Bill in 1900, as to the condition of the estuary waters, and as to what became of the sewage coming from these townships after it entered the bay.

13224. You, therefore, examined the state of the water in the bay?—Yes, I very carefully examined the state of the water in the estuary from the Pigeon House harbour to the mouth—that is, between the two lighthouses of Poolbeg and the Bull: and for the purpose of getting pure sea water samples I had occasion to examine one or two samples from the bay.

13225. When you speak of the estuary you mean something outside what is shown on the map before us?—Yes, I mean further to the east than is shown on that map.

13226. You notice where the Rathmines and Pembroke sewage is discharged on that map?—Yes, I call it the Liffey estuary.

13227. It is called the Crab Lake basin on the map—you investigated the state of the water there?—Yes.

13228. And you found certain currents during ebb and flow tides?—Yes. At the commencement of the examination I made float experiments in conjunction with Mr. Parry, M.Inst.C.E., from the outfall of the sewage to the mouth of the harbour at the commence-

ment of the ebb tide. It was an average tide on a perfectly calm day, and we found our floats discharged out of the mouth of the harbour in about an hour and a quarter from the start.

13229. During the ebbing tide?—Yes, during the commencement of the ebb tide.

13230. What became of them subsequently?—They went into the bay towards Kingstown.

13231. Did you watch them in the flowing tide?—No we let them go. What I simply wanted to do was to form an estimate of the path of the sewage, and I collected samples in the path of these floats. My object was not so much to determine the currents as to collect samples in the path for analysis.

13232. Did you not examine whether any of the floats returned to the Clontarf shore?—No, I took it for granted that they did, on the authority of the harbour engineer, Mr. Griffith, at low neap tides—that is, when the tidal action is most sluggish. I collected samples at the mouth of the estuary between the lighthouses, on a perfectly calm day, just at low water of a neap tide, and half an hour afterwards; I determined then the degree of pollution, and I found it was surprisingly small, and I obtained evidence which satisfied me that the pollution did not extend much below 7 feet below the surface, and that below that was pure sea water. I found that, in calm weather, the tendency of the polluted sewage was to lie over to the south, and along the south wall, while on the north side of the channel the water was fairly pure. That was during calm weather. The explanation, I think, is simple; there is a large surface of foreshore exposed at low neap tide on the north side, and but little on the south side, of the channel, and you have the current setting in from the north towards the south, which undoubtedly in calm weather drives the surface waters towards the south wall. Of course, with a south-easterly wind, there would be a tendency to drive it towards Clontarf. But, as a chemist, I would suggest that the appearance of the water looks worse than it is owing to the floating matters which, if the wind becomes prevalent in one direction, give a bad appearance. In flood times there is a very large amount of fine clay brought down from the townships and from the Dublin sewers. That subsides very slowly, and discolours the water very much, and that being driven up on the Clontarf shore has given rise to the suggestion that the crude sewage goes to Clontarf, but I don't think an appreciable quantity of crude sewage goes to Clontarf.

13233. What is the total depth of the channel?—I think Mr. Griffith could best give that evidence. I have collected samples from the bottom at low spring tides, and I found it about 14 or 15 feet.

13234. How much of that do you reckon to be salt water?—It was an exceptionally low spring tide, and there was hardly any water except in the deep water channel, and starting opposite the Pigeon House harbour, where the Corporation precipitation tanks are being built, I found that in the bottom water samples the ratio of river water to sea water was 1 to 5, 1,122 yards lower down, and still in the deep water channel the ratio as 1 to 6·4, and 1,870 yards below it was 1 to 6, but probably the difference is due to experimental error.

13235. Then the top layer was salt water?—At the surface immediately opposite the Pigeon House harbour the relation was as 3 to 1, and 1,122 yards lower down it was as 1 to 1, and 1870 yards lower down still it was as 1 to 2·4.

13236. So that the fresh water current runs over the salt water current?—Yes.

13237. Is the salt water running in, and the fresh water running out at the same time? I think at the commencement of the flood tide you have an under current of pure sea water coming in, and the fresh water flowing down over it. I believe that has been the experience in the Severn.

13238. Then your contention is that if the sewage is allowed to escape at the beginning of the ebb tide it gets carried right through the mouth of the harbour, and gets diluted with sea water, and that what returns is not worth speaking of?—Yes, and you can see it for yourselves. Even at the most unfavourable conditions I have never found even the surface water fouled—what is there still retains some aeration, and the object lesson of that is simple. If the solid matters had not been allowed to deposit in the Liffey and the Tolka the problem would be solved, and still better when the Corporation works allow the effluent to be discharged at the Pigeon House harbour, and not higher up. The only disagreement I have with the Corporation works is that I think they should not discharge at all states of the tide. I think if they increased their tank capacity and adopted the septic tank type of tank, and discharged at ebb tide only, they would have the river quite pure, and the estuary purer than at present, and they would have very much less difficulty with the sludge.

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13239. You don't treat the sludge from the Rathmines and Pembroke sewage?—It is a very peculiar kind of sewage, it is not treated but it is not ordinary sewage; it is purely domestic sewage, largely diluted with water—subsoil water—and there is no heavy detritus carried down; at least I have not been able to find any. Whatever solids are discharged are light, flocculent stuff, due to domestic sewage.

13240. Do they adopt any plan to catch the detritus?—They have a system of catch pits which were built at the instance of the Port and Docks Board, but these catch pits are not things which modern engineers regard with favour at the present time, but so far as stopping mud bank forming material they have proved extremely successful. If the Commission are going to visit the estuary I would suggest that they should examine it at low water. The outfall of the Rathmines and Pembroke system has been at work for over 20 years, and they will see—unless something extraordinary has happened since I was there—that there are none of the permanent deposits of sewage such as characterise an ordinary town outfall. The only objection I can offer to the outfall of the townships is that the sewage is not sufficiently screened; a lot of floating matter now gets into the estuary from it which might be prevented.

13241. Which floats over to Clontarf?—Yes, it floats anywhere, and it leaves an amount of deposit on the stretch of sand adjoining the outfall, and exposed at low water, which looks bad; with a north-west or north-east wind it is very noticeable.

13242. I understand you to say there is a considerable quantity of nitrates in the sewage from Pembroke and Rathmines?—Yes.

13243. Have these districts been inhabited for a long time?—Yes, I think so. There is no doubt the subsoil is enormously polluted. Evidently in the pumping the pumps draw in a lot of subsoil water.

13244. That has been subject to former pollution?—Yes.

13245. But that wil have a considerable purifying power?—Yes, undoubtedly.

13246. Then your suggestion is that a satisfactory way of disposing of sewage is to merely settle it, and then run off the clear effluent at the beginning of the ebb tide?—Yes, I think that is the plain lesson taught, not only in the Rathmines and Pembroke outfall, but in the case of Dublin itself.

13247. Have you any views you wish to put before us regarding the disposal of the sludge produced at the outfall?—I cannot say I have, but I think if properly treated it could be safely used for the reclamation of land.

13248. (*Colonel Harding.*) I gather from what you have told us that what you consider the innocuous character of the Rathmines and Pembroke sewage is due to the withdrawal of the suspended matter in these catchpits?—Exactly.

13249. Can you give us any idea of the volume of matter abstracted by them?—I am sorry I am not in a position to answer the question.

13250. Are the results published?—Yes, they are given in the paper published by Mr. Parry and myself, and already referred in my memorandum.

13251. You speak of screening taking place?—No, it is the absence of it that I complain of.

13252. You think it is not sufficient?—It is quite insufficient.

13253. You consider that the sewage from these townships, in order to be innocuous, should have withdrawn from it the greater part of the suspended solids?—Yes, but it is more a sentimental point than a reality, because the suspended or rather floating matters, that I think are an eyesore, are not so much sewage as paper, corks, matches, etc., which when accumulated near the outfall

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by a prevalent wind look bad, and it is unnecessary, because by moderate screening they could be stopped.

13254. Is there a proposal in connection with the sewage of these townships to screen the sewage?—I don't know; I have no official connection with the townships.

13255. Where does the present outfall from these townships go into the bay?—It is half way down between the Pigeon House Harbour and the mouth.

13256. As to the condition of the Liffey itself, there has been a good deal of complaint as to bad smells?—Yes, certainly.

13257. Do you attribute that to any extent to the fact that the sewage is kept banked up in the sewers and is then discharged in a partly putrefying condition; I am referring, of course, to the river Liffey itself?—I think it is more due to the sludge banks all along the Liffey bed and also along the Tolka.

13258. You don't think the backing up of the sewage helps to increase that state of things?—Undoubtedly it must add to it. I find it most offensive at low water, especially on a sunny day.

13259. But that would be avoided if all the sewage was carried to the proposed outfall?—Yes.

13260. And you anticipate that the condition of the river will be enormously improved?—Yes; I agree with the Corporation works up to the point of treatment. I don't think treatment is necessary.

13261. You think that bringing the solids to the outfall, and having settlement tanks there, is the proper method, but that does not seem to apply to the outfall from these two townships?—But the heavier matters are already abstracted by the catchpits, and there only remain some other matters which could be separated by screening; the rest, I think, does no harm, and I think you will find that to be the case when inspecting the neighbourhood of the outfall at low water.

13262. If there was a development of the population or the establishment of manufactures in these townships you would consider that some process of settlement should be carried out with regard to the sewage from these townships in the same way as with the sewage from the city?—I hesitate to agree with the precipitation with lime, for I am very doubtful about its efficacy as applied in the manner described by Mr. Harty. The Dublin water is very soft, and I doubt whether there will be much result from lime treatment, and even then they would not have separated all the solid matter by their method, and they would probably leave in their effluent as much solid matter in bulk as now comes down from the Rathmines and Pembroke townships.

13263. You mean suspended solids?—Yes. So that if any condition of things arises which would compel the Rathmines and Pembroke people to clarify their sewage, then the Corporation must adopt a very much more efficient system than they propose to adopt.

13264. Have you any opinion about the advisability of adopting the simple septic settlement plan?—From what I have seen of septic tank work I believe if tanks of that type were relied on by the Corporation they would get a sufficiently good effluent to discharge during the first four or five hours of the ebb tide.

13265. And they would then have a much less quantity of sludge to dispose of?—Yes.

13266. Is the space available at the Pigeon House fort sufficiently large to permit of that being done?—That I am not able to say.

13267. The tanks as proposed appear to cover most part of the area, but in principle you are disposed to think that septic settlement would be more effective than lime precipitation for this particular sewage?—I think so.

13268. (*Mr. T. J. Stafford.*) Were your float experiments of an elaborate nature?—No; they were simply made to determine the path of the sewage as it passed out of the outfall of the township system to the mouth of the harbour.

13269. Because they don't seem to agree with Mr. Harty's float experiments?—I would suggest that that should be left entirely to Mr. Griffith, for he has gone very fully into it. I believe the time Mr. Griffith found the floats showed a great tendency to return to the harbour was at neap tides, and that was the reason, as I have stated, I paid special attention at neap tides to the condition of the estuary water, and in the memorandum I have handed in I have given data to show that at neap tides the water is nowhere anything like seriously polluted. There is undoubtedly a good deal of sewage lying in the estuary, but I have given evidence to show that it is not sufficient to go anywhere near fouling the surface water; it affects very slightly the water at a depth below 7 feet, and it is all cleared out at the ensuing flood and ebb tides.

13270. If things like corks and matches are blown on to the Clontarf side, is it not likely that portions of the solid matter and sewage itself would also find its way over there?—As a matter of fact there is very little suspended matter in the nature of sewage solids.

13271. But there is a tendency to go in that direction?—Undoubtedly, and the floating matters that go to Clontarf shore after two or three days of south-easterly wind give the whole shore an extremely bad appearance.

13272. That is the prevailing wind?—That is, and therefore these matters should be excluded.

13273. You don't think the sewage matter would be likely to follow the same course as the floating objects like corks and matches?—There is not sufficient of it, I think, to do any harm; I have not detected much solid matter in the Dublin sewage.

13274. But the tendency would be in that direction?—If it were there, certainly.

13275. Would you not advise the Rathmines and Pembroke Board to adopt a system of septic settlement such as you advise the Dublin Corporation to adopt?—I think it would be an improvement certainly, but I would point out that the objection to solid matters if they exist being blown in by the prevailing wind might be urged very seriously against the proposal of the Corporation to discharge their sludge at the Bailey on the other side of Howth, because with a north-east wind any floating matter will certainly be blown along the shore at Monkstown and Kingstown.

13276. How far is the Bailey from Kingstown?—About seven miles.

13277. And you think it will find its way back so far?—I have seen it occur. I have seen the contents of the Eblana barge on the shore there after two or three days of an easterly wind.

13278. But the heavy sludge matter would sink where it was discharged?—Yes, but that is only the road detritus. It is the floating matters that are carried about.

13279. But you don't think that sewage matter discharged into that enormous volume of water will find its way back to Kingstown in any shape which would be objectionable?—I agree with you that anything broken up and discharged so far away would be so diluted that it need not be considered.

13280. (*Chairman.*) And such matters as corks merely make the shore look ugly?—Yes.

13281. (*Mr. T. J. Stafford.*) Is it of importance when you have the sludge discharged at such a distance out at sea?—I am talking from the appearance point of view; it is unsightly, and I think you must approach the question of the disposal of sewage at a seaside resort with very different ideas from those with which you might regard a place with a sea border like the South Wall, the Dublin estuary.

13282. But I take it you rather agree that both the Rathmines and Pembroke Board and the Dublin Corporation should adopt some system of septic settlement for their sewage where they propose now to discharge it?—Yes, I quite agree in that.

13283. And that they should discharge at ebb tide only?—Yes.

13284. Could they do that?—Well, undoubtedly the Rathmines and Pembroke people could do it.

13285. There is sufficient room on the South Wall for the purpose?—I think so; they could get space enough for that.

13286. (*Mr. Spencer Harty, C.E.*) Mustn't the sewage become deposited for the time being?—Better not get into that.

13287. (*Dr. J. Burn Russell.*) What is the character of the population of these two townships—isn't the district a fashionable one?—Yes, they are very thriving districts, and have large residential populations.

13288. I ask that in reference to an answer you gave some time ago—how has the pollution of the subsoil water arisen in a district of that character?—I have not sought an explanation of that.

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13289. There is nothing usually in a fashionable district to cause subsoil pollution?—I can only speak of the fact.

13290. (*Mr. T. J. Stafford.*) Portion of the Rathmines district has a poor class population?—Yes.

13291. (*Dr. J. Burn Russell.*) You cannot explain the subsoil pollution on any of the ordinary theories that I can see?—Except that the sewers are leaking.

13292. It is admitted, however, as a fact that the subsoil is polluted?—Yes, I don't think anyone will deny that.

13293. Who can tell us about the size of these catch-pits and the quantity of material taken out of them?—The officers of the Main Drainage Board of the two townships would be the proper persons to give the information.

13294. It results in the production of a large quantity of more or less offensive sludge in a thickly inhabited area?—Yes. The catch-pit system is not a system I am at all intent on defending; in fact, I can say nothing whatever about the main drainage system of the townships—I am simply concerned with the disposal of their sewage.

13295. (*Chairman.*) There is one thing as to which you can perhaps enlighten us—in Belfast the water is extremely full of lime?—I am not quite certain about that, and I cannot speak from personal knowledge about it.

13296. As regards the growth of this ulva, is it conceivable that by increasing the amount of lime in the sewage, by any lime treatment, the growth of the ulva might be helped?—There can be no doubt the condition of the water in the estuary at present is quite favourable to the growth of that seaweed, and on Clontarf shore you will find a remarkable growth of it.

13297. (*Colonel Harding.*) Do you think the growth would be encouraged by the dissolved organic matter in settled sewage?—Dr. Letts, who has given a good deal of attention to that subject, has published results of his investigations which go to show that it is the oxydised sewage, chiefly the ammonia compound, which encourages the growth of the ulva.

13298. That would be contained in the settled effluent?—I doubt whether a merely settled effluent would be favourable to the growth of ulva. I think it would require oxydisation first.

13299. Then you don't fear any extra growth of the ulva from a settled sewage system?—No.

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13300. (*Chairman.*) You wish to put in a paper on the utilisation of sewage sludge?—Yes.

13301. Have you anything you wish to add to it?—No, I think you will find everything necessary in it, and I especially draw attention to Sir Charles Cameron's remarks on the paper. He was present at the reading of the paper and the subsequent discussion on it.

13302. Then you think it would be desirble to reprint the discussion also?—Yes, but that is a matter for the Commission.

13303. You think it contains valuable matter?—I think it does.

The following paper and discussion on it were then given in evidence by the witness:—

The problem besetting every engineer dealing with sewage drainage, is how, when he has collected the sewage, he is going to get rid of the solids contained therein. This is comparatively an easy matter in the case of small towns situated on the seashore, but becomes more perplexing in accordance with the increased size of the town or city which has to be dealt with, as, in the case of large deposits being sent out with the tide, there is always the danger, almost the certainty, of such deposits being swept back to a large extent, and re-deposited on the foreshore, there to become a nuisance and a danger, to say nothing of being a waste of valuable material. Then, as we go further inland the problem becomes more pressing; for, you must either pollute your rivers (again losing matter of value), or you must treat it as a manure, and sell the sludge or cake to the farmers, or else utilise it on sewage farms. Both these latter alternatives have their respective values, and also their striking disadvantages; in the former case the value of the sludge to the farmer, depends largely upon the form of precipitant employed at the settling tanks; and even then, if suitable for their particular crops, they object to sending their horses and carts to draw with each load more water than manure; and again, owing to presence of such precipitation material as is most usually employed in the tanks, the full decomposition of the constituents of the sludge is delayed after being spread over the land; and, as a consequence, the best results are not obtained for the farmer as speedily as he can obtain them from artificial or natural manures. The question of sewerage farms is one which I do not feel myself inclined to enter into, but I understand that to be effective the area must be great, so as to get the acme of efficiency, and the sludge should be dug in, and the ground left fallow for three years to obtain the best results; consequently, in any up-to-date sewerage farm, you could only have one-third of it under cultivation at any one period; but, there is a much graver aspect of the sewerage farm system, and that is, the indestructibility of disease germs by the ordinary methods of precipitation employed at depositing stations, and the absorption of such germs into the cellular tissues of the vegetables grown on such farms, and their transference in the course of their use to the human body, and the resultant spread of such diseases as typhoid, etc. This alone should lead us to do all we could to utilise in some other way the valuable asset that every community produces, which many throw away, others misapply, and all would like to recover. But the question is, how to do this efficiently and economically; how to produce value where at present we have loss and danger. These were the questions that presented themselves to my mind some years ago, and to which I endeavoured to get a satisfactory answer. I knew that many workers before me had gone into the same field, and retired, baffled and disheartened. In the course of my investigations I came to the conclusion that in place of looking for, and dealing with, a single resultant of the quartette that may be derived from the sludge deposit, the only thing for an economical working would be to obtain all four (main) products, and that, if possible, at a single operation. Leaving out my earlier efforts I will endeavour to give a succinct account of my ideas and experiments dealing with the deposit from the time it is filter-pressed and delivered at the works.

My object is the distillation of the filter-pressed sewage obtained from any sewage disposal works where the use of filter-presses is adopted, and, assuming the cakes of sewage can be obtained first hand, and in such a condition as to bear transit, then the process has for its ultimate object the production of oil, ammonia (as ammonia-water), and a solid residue which is to be convered into cement—for which purpose it is admirably fitted, especially where lime has been used as a precipitant in the separation of the sewage into sludge and effluent, as is the case in London.

The London sludge contains:—

Moisture	58·06	Nitrogen calculated
Organic matter	16·69	as amm. sulphate ·87
Mineral matter	25·25	per cent. wet cake.

The mineral matter contains:—

Carbonate of lime	7·94
Free lime	2·45
Silica	8·08
Oxide of iron	·97
Alumina	3·39
Phosphoric acid	·65

From mere inspection of the above results it will be seen at once that by simple drying of the sludge it would give a body capable on distillation of yielding very large amounts of ammonia, and also an oil, which would be of value as a carburetting material in the manufacture of gas. Experiments were first made on a small scale in the laboratory with pressed sludge obtained in London, and very promising results were obtained; then an ordinary gas retort was tried, with inferior results both as regards the yield of oil and ammonia, and it was also conclusively shown that the vertical position of the retort was the proper one if the largest yield was to be obtained, and also that the sewage must be distilled in a retort capable of giving two different temperatures (or preferably four), one (the lower) at which the elements present in the material chemically combined to form the oil vapour, and another at which the nitrogen (still present as such in the spent

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shale) was burned, so to speak, in an atmosphere of steam and converted into ammonia by the aid of the caustic lime produced in the operation. With these facts in view a small experimental retort was set up at Barking and tried by producer gas—and from this small and very imperfect apparatus considerable experience was obtained and oil and ammonia sulphate produced. It was shown that external heating of the retort was of no value if a high percentage of ammonia was to be obtained, and therefore a retort on the principle of the Young and Bilbey is the most suitable for the purpose. The oil obtained from the sewage would be of value for either burning or converting into gas. The residue coming from the retort was a valuable body, and could be converted into a very fair cement worth at least 10s. per ton. A very large large proportion of a non-luminant gas was produced during the distillation, which could either be turned into the retort benches or used as fuel to dry the cakes of sludge before they were distilled. The method of distillation to be adopted would be on very much the same plan as that used in Scotch shale works, except, that before the sewage could be distilled it must be dried, and this would be done by the waste gases arising from the retorts, and by carrying the hot gas flues under floors on which the cakes of sewage were placed. With this exception the process would be identical with the shale distillation; oil, gas, and ammonia water being produced and condensed in suitable receivers, and afterwards separated, and the ammonia obtained in the form of sulphate, and the great factor in the production of oil from shale is the number of pounds of sulphate which is obtainable from the ton distilled. This in Scotland may be taken as between 25 and 37 lbs. per ton (the highest average).

Appended is a copy of the balance-sheet of an oil works using Henderson's retorts, and from that the following figures have been obtained:—

1. The yield of crude oil per ton of shale is about 37 gallons.

2. The yield of ammonia sulphate is about 18lbs.

3. The cost of mining and obtaining the shale is 4s.

4. The cost of distilling and producing the oil is 4s. per ton of shale.

5. That by far the largest profit in the manufacture is obtained from the production of the ammonia sulphate.

Now it is evident that if the compressed sewage can be obtained from the sewage works for the simple cost of transit, or at a nominal cost, or utilised by the authorities on the spot, and that by distillation it can be made to yield a high percentage of ammonia, and also give oil, and a valuable residue in the form of a cement, then a very valuable return will be made by treating such material.

From the results of a great number of experiments made, both in the laboratory and on a larger scale, it has been proved that on the average about 9 to 10 gallons of oil would be obtained, and from 57 to 65lbs. of sulphate of ammonia; in some cases over 100lbs. to the ton was obtained.

The following are the results:—

Wet Cake from	Ammonia Sulphate.	Residue.	Oil per ton.	Water.
Cross Ness - - - - - -	57·56 lbs. per ton - -	39·00 per cent. -	7 to 11 gallons - -	54·10
Leyton - - - - - - -	59·80 „ „ - -	68·40 „ -	9 to 10 „ - -	52·00
Wimbledon - - - - -	65·63 „ „ - -	56·00 „ -	5 „ - -	51·00

In carrying out these experiments I found that it is necessary that the cake should be nearly dry (not containing more than 15 per cent. of water), before it enters the retort, and for this purpose the waste heat from the retorts would be economised, and also the gas evolved during the distillation; even if extraneous heat had to be applied the cost thereof would not equal the cost of mining the shale, which amounts to 4s. per ton, and therefore, if we obtain from the sewage products which are as valuable as those obtained from the ton of shale, the process still remains on a remunerative basis.

The oil obtained is neither so large in quantity nor so good in quality as crude shale oil, and would not be worth more than 1½d. per gallon, for carburetting purposes, but the yield of ammonia would be nearly double that obtained from shale, whilst the residue when ground would certainly be valuable as a cheap cement and quite good for the purpose of making concrete.

The yield of one ton of sewage cake containing say 15 per cent. of water would be roughly as follows:—

	s.	*d.*
20 gallons crude oil at 1½*d.* per gallon -	2	6
80 lbs. ammonia sulphate at 1½*d.* per lb. -	10	–
10 cwt. of residue suitable for cement -	5	–
	17	6

The cost of obtaining the above would approximately be as follows:—

	s.	d.
Drying 2 tons of sewage cake, say 2s. per ton for coal used in addition to the waste heat derived from retorts	4	0
Air drying would reduce this to 6d.		
Cost of distilling and producing the crude oil and ammonia - - - -	4	6
Cost of crystallising the sulphate of ammonia, and cost of sulphuric acid necessary - - - - - - -	2	6
	11	0

The amount of ammonia is taken at much less than that really obtained from the process, even when working with a very imperfect apparatus, and the value of the residue is certainly taken at a very low figure. The proper method of really testing the process would be to erect a bench of say 10 Young and Bilbey's retorts, capable of passing about 30 cwts. or 2 tons of shale in 24 hours each. With sewage very possibly a little more might be got through.

The cost of these may be taken at from £55 to £65 each, and there is no doubt that by the use of these retorts a much higher yield of ammonia would be obtained.

Following up my own experiments I had a consignment of pressed cake sent from Glasgow to a large shale oil works, where by the courtesy of the heads of the works they carried out a distillation for some of the pressed-cake in their experimental works, with most satisfactory results, as you can see from the return they certified to me from their tests. The results they got were as follow, from the cake as received:—

Moisture - - - - - -	71·335
Organic matter - - - - -	10·210
Ash - - - - - - - -	18·455
	100·000

On distillation in experimental retort, in presence of steam, the following yields were obtained:—

	Original Sample.	Dried Sample.
Oil (lbs. per ton) - -	11·779	41·094
Sulphate of ammonia (free) (lbs. per ton) - - -	19·884	69·367
Total (lbs. per ton) - -	24·486	85·421

It will be observed these figures are not mine, but those from a flourishing industry which makes the greater portion of their money out of the sulphate of ammonia produced; and in their experiments in an unsuitable retort, adapted for the distillation of shale, they succeeded in getting some fifty pounds of sulphate of ammonia per ton more out of the sewage contents than with shale; this does not take any account of either the gas, some 4,000 cubic feet per ton of cake produced, nor yet the oil or the residue of the combustion which, properly treated in the retort, yields a valuable resultant in the form of a cement. In dealing with the sewage on a large scale, I should propose

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that the retorts be set up in benches in a manner similar to a shale works, only differing slightly in construction to allow of the spent residue being drawn from time to time, the gas could be used for firing fresh charges, and also the boilers necessary to produce steam for injection into the retorts, for the purpose of procuring the largest yield of ammonia. The oil is so small in quantity and so valueless in price that its principal use would be for carburetting a certain proportion of the produced gas for the purpose of illuminating the works.

The few words I have said are not put forward other than as a record of experiments carried out with a fair amount of success, and now offered with a view of getting the opinions of those more able than the author, and to draw attention to a most valuable matter of utilisation, and which at present is either a danger and a nuisance, or is thrown away.

COST OF DISTILLING ONE TON OF SHALE, AND PRODUCTS DERIVED THEREFROM.

	£. s. d.
To total cost of getting 69,808 tons of shale equal to 4*s.* per ton	13,994 – –
„ Sulphuric acid required equal to 6*s.* 5*d.* per ton	1,945 – –
„ Coal, 1*s.* 3*d.* per ton	4,403 – –
„ General repairs, 4*s.* 5*d.* per ton	1,394 – –
„ Wages, 1*s.* 8*d.* per ton	5,906 – –
„ Expenditure on horse labour, &c., expenses, commission to managers and clerks, salaries, &c. Taxes and surface damages, 4*s.* 5*d.* per ton	1,242 – –
8*s.* 2½*d.* per ton £.	28,884 – –

	£. s. d.
By Price of 2,555,680 galls. of oil produced from 69,808 tons of shale (or 36·60 galls. per ton)	28,842 – –
„ Price of 11,179 cwts. of ammonia sulphate, 13*s.* 11*d.* per cwt.	7,801 – –
„ Price of 80,661 galls. naphtha	458 – –
	£. 37,101 – –

The profit derived under each head may be held to be as follows:—

	Prices received.	Cost.	Profit.
Oil	£.28,843	£.25,268	£.3,576
Ammonia sulphate	7,801	3,188	4,612
Naphtha	458	311	146

Mr. James Dillon said they were very much obliged to the author for having taken the trouble of bringing this subject before the institution. If the paper and the figures put forward were found to be accurate, it would be a matter of the greatest importance to engineers. If it was found to be a successful way of dealing with sewage sludge it would alter the whole character and reduce the cost of sewage works, inasmuch as if they could use the sludge profitably then they would be able to do away with all those costly works which they have had to adopt in order to try, even at a loss, to get rid of the sludge to consumers for the cultivation of their lands. He had visited a large number of sewage farms in different parts of England, and in most of them, whether large or small, he found they had great difficulty in getting rid of the sludge. In the Birmingham sewage farms they had kept on adding to the farms, and still had not enough land, and they were now taking steps to adopt some other system of dealing with the sludge. They had found the quantity of sludge was so great that if all used it would injuriously affect the productive powers of the land, and there were other objections in addition to the great cost.

Manchester was in the same way. They had tried different methods from time to time, and spent enormous sums of money, and they had become disheartened at the results. They were now considering the septic treatment, but the Local Government Board (in England) were not quite satisfied with this method, unless largely aided by land filtration to preserve the river waters from sewage pollution, thus adding considerably to the enormous cost of works of this description.

If the methods mentioned by the author were adopted it would help them very considerably out of their difficulty.

Coming nearer home, to their own city, the Corporation were now expending enormous sums of money in building a main drainage system, and they intended to bring the sewage down to somewhere near the Pigeon House, where it would be delivered into tanks, to be pumped from them into ships and brought out to the sea. These tanks would have to be very large and costly, and they would have to be emptied at all times of the year. This would be very expensive and troublesome, especially during the winter, requiring powerful steamboats or tugs. Other towns had tried different methods of delivering sewage into the sea, and where there was a tidal current flowing in the right direction out to sea and away from the shore, it had turned out a great success. But if the facts and methods mentioned by the author were correct we were undoubtedly delivering a certain amount of gold into the sea from whence it could not be recovered. He thought the Corporation ought to give a trial to the methods referred to in the paper with a view to see if they could not reduce the enormous cost of dealing with the sewage in the way originally intended for the City of Dublin and the surrounding districts.

Sir Charles Cameron said the subject which the author had brought before the institution was at all events to be regarded as a very important one. Quite apart from the particular scheme for disposing of sludge which the author had dealt with, they knew it was a matter of great importance to be able to deal economically with immense quantities of semi-solid matter which were produced in the case of treatment by precipitation or subsidence of the sewage of a large city like Dublin with its 300,000 people. There was no doubt when the sludge which was produced had to be conveyed out to sea there was no return value whatever from the labour bestowed upon the disposal of the sludge. The country was not enriched by the production of any one article. They had no material for making cement. They had no material for the manuring of their fields. But if they treated the sludge in such a way as suggested in the paper they would get something out of it which would be of value. There might be an increase of expenditure in comparison to the cost of bringing it out to sea, but still there would be the gain to the country, for they would have something to put into their fields, and something to use in their industries.

He thought that was the idea that the author had in taking up this question. The matter became more important in the case of inland towns. He had always held in the case of Dublin all they had to do was to send a clear liquid out into the bay, no matter how much dissolved organic matter it might contain. But that was not the case in dealing with such large towns as Birmingham, where the sewage should be properly treated so as to convert it into liquid without having a large quantity of dissolved matter which would very often prove offensive by undergoing secondary fermentation. In dealing with this question, whether in towns on the sea coast or in inland towns, there would be large quantities of matter precipitated, and the author had said a great deal with regard to the proper way of treating that sludge. There was a great disadvantage in carrying it out to the sea. Anyone who had made a voyage on the Corporation barge "Eblana" would tell them how unpleasant it was. They had the same unpleasantness in Liverpool with their barges. There was a proposal that the sludge should be used for reclaiming the foreshores along the south side of the Pigeon House wall! That part of the foreshore is anything but salubrious. He was inclined to think there was a good deal in the paper, but he was not going to say how the calculations would work out in actual practice; but he thought it would be worth while to give a trial to the process. It was not necessary that a great expenditure should be incurred in doing so. They did not require any large expensive plant for testing whether this was an

Mr. M. F. Purcell, M.INST., C.E.

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economical process or not. He thought it would be worth while in the case of Dublin to see what products could be obtained per ton of sludge, and to see whether it would be more economical to adopt the author's proposals than to convey the sludge out to sea. With regard to the sulphate of ammonia, he thought the author had not exaggerated the value of the ammonia produced. At the present time it would be worth more like 6d. per lb. He agreed with the author that the value of the oil produced would not be very much. He considered it could only be used to burn in the furnace. The really substantial product would be the ammonia. They had to consider whether the sulphuric acid would be purchased. A large portion of the profit in making artificial manures was derived from the manufacture of the sulphuric acid, and if the sludge manufacture was on a large scale it would be desirable to have the sulphuric acid manufactured, but if that was not convenient the sulphuric acid could be purchased.

The subject of the paper was a very important one, and it would be of great importance to Dublin in a couple of years. He had calculated that the amount of human excreta of the city annually was equivalent to a value of about £93,000. Of course, it would be impossible to get so much money out of it, but if they could get 10 per cent. it would be a matter of great importance.

Mr. W. J. Haslam said he would like to know more about the cement mentioned by the author. Could he give them any analysis of the residue coming from the retort showing the percentage of alumina, and whether it was really valuable as a material for producing cement. Sir Charles Cameron had stated that the oil produced was practically worthless, and he did not see anything in the paper to show whether the residue was a suitable ingredient for the making of good cement. Then, supposing the cement was worth nothing like the oil, it would reduce the value of the product to 10s., whereas that same product would cost 11s. to produce. Unfortunately there were not many large towns in this country, and any they had were on the sea coast, where the sewage could be dealt with in other ways.

The President said they all ought to be very thankful to the author for bringing this paper before them. A short time ago they had a paper on the "Disposal of Sewage." Everything connected with the question was both difficult and important, inasmuch as it affected the lives and pockets of the community. In this particular paper they had the utilisation of the sewage, which, in other words, means first the production of sludge, then the utilisation of the sludge. As had been said, all their towns were not large towns, and their greatest difficulty in some places was to make the sludge. In considering questions of this kind it was well to remember that the spending of large sums of money was an advantage, even though the returns were not very much in excess of the outlay.

As regards the cement, the author had not stated the results of his experience of this cement in concert. Of course, its value would depend upon the proportion of sand or gravel used in the manufacture of the concrete. It was also important to know what were its setting properties. The paper was so entirely chemical that he did not feel himself competent to say very much upon it.

Mr. Purcell, in reply, said he had seen the effects of the Manchester sewage farms, also of the Cambridge sewage system, where the River Cam had been destroyed, not a fish being left alive in the river, and the sewage and consequent germs of disease were floating about on every side. He had got some samples of the vegetables that had been grown on sewage farms, and had analysed them. In a number of them he had found disease germs that had been absorbed by, or into, the cellular tissue. With reference to the Corporation barges, and the non-return of the deposited refuse and sewage, he could only say that when he was a youngster he used to sail round Howth, and on the far side he could point out where he was able then to get six fathoms of water, and now he would not dare to sail over that part owing to the material which had been carried in there by the current, and which had come from the Corporation barges dumping at sea. With regard to Sir Charles Cameron's suggestion about depositing the sludge on the foreshore, or south wall of the Pigeon House, he did not think that would be a good plan, for the effect of the wind, sun, and rain on it would not make it more pleasant than it was at present, and, indeed, under their combined influence might eventuate in a grave danger to the City of Dublin. With reference to the cement and concrete, he had tried it himself, and also had got it tried by Professor Butterfield, F.I.C., F.C.S., with very satisfactory results. In making concrete with the residual cement they could get a very good concrete with about 50 per cent. of sand. They could also use it in the proportion of 1 to 5, and they would find this very profitable.

Mr. F. Watson.

Mr. Forbes Watson, Examined.

13304. (*Chairman.*) You are chemist to Messrs. Guinness, brewers?—Yes.

13305. You have handed in a paper dealing with the amount of sewage discharged from the brewery into the Liffey?—Yes, and showing the alkalinity of the discharges.

This is the paper:—

1. Approximate quantity run down sewers, 6 a.m. to 6 p.m. and 6 p.m. to 6 a.m.—6 a.m. to 6 p.m., 700,000 gallons; 6 p.m. to 6 a.m., 600,000 gallons.

2. Largest quantity in any one hour.—80,000 gallons.

3. Character of refuse.—See Mr. Forbes Watson's report dated 25th July, 1902.

4. Temperature of hottest and approximate quantity per hour.—* Not exceeding 100° F.—3,000 gallons per hour, but only for one hour per day.

* This water is first run into a tank and there cooled down to below 100° F. before being discharged into the sewer.

5. Whether chiefly alkaline, and, if so, whether intensely so.—See Mr. Forbes Watson's report dated 25th July, 1902.

Copy of Mr. Forbes Watson's Report.

25th July, 1902.

Samples of discharges were drawn to-day in the following places:—

1. Drain under No. 1 James Street.

2. No. 2 brewery drain.

3. Barm back and floor washings (runs under 82, James Street).

4. Drain from tunnel and No. 10 vat house.

The characters of these liquids were as follows:—

1. Coloured very faintly brown. Turbid from easily separable matter in suspension. Faint pleasant smell of beer.

2. Colourless liquid. Turbid from the presence of oily substances. Odourless.

3. Slightly brown in colour and turbid. Contains yeast cells in abundance. No disagreeable smell.

4. Coloured faintly yellow. Very slightly turbid from the presence of easily separable suspended matter. No disagreeable smell.

The alkalinities of these liquids were as follows:—

1. 24 parts per 10,000 of alkali calculated as sodium carbonate.

2. 18 do. do. do.

3. 16 do. do. do.

4. 16 do. do. do.

The samples of the discharges referred to in Mr. Forbes Watson's report of the 25th July, 1902, were obtained by taking at each of the four points a sample of one pint every ten minutes for three hours, the eighteen samples in each case being mixed together.

13306. That is the paper you hand in; what is the approximate quantity of sewage you send into your sewers in the 24 hours?—About one million and a quarter gallons.

13307. That is distributed pretty equally in the day and night?—Yes, but it is made up of two different kinds of water in almost equal proportions. One is water we use to wash out our vessels, and the other is well water which is obtained from deep levels, and is practically sea water. That is used for cooling pur-

Mr. F. Watson.

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poses, and the two are mixed in equal proportions—about 600,000 gallons of each in the 24 hours.

13308. Is the 80,000 gallons, which is the largest quantity sent down in any one hour, pretty equally distributed?—Yes, it is very evenly distributed.

13309. You have drawn a number of samples from various places?—Yes, from four places, which represent pure brewery effluent, unmixed except in one case, and that very slightly with domestic sewage.

13310. Do you turn out any large quantity of oily substance?—No, the oil is only derived from the floors below the engines.

13311. Then you have not a large amount of suspended matter in the effluent from your premises?—No.

11312-13. Is that sample from the Rainsford Street sewer a fair sample of your sewage?—I believe that the drainage from a large number of houses at the back of the brewery finds its way into that sewer.

13314. Still, it appears to be very pure sewage?—Yes; judging by appearance it seems good.

11315. And that sewer forms a large part of your discharge?—No, it only takes in some part of it.

13316. Does not a large part of your 1,300,000 gallons go into that sewer?—No, I think not.

13317. (*Colonel Harding.*) What sewer does the effluent from the brewery most go into?—Thomas Street and Victoria Quay sewers.

13318. (*Chairman.*) They go direct to the Liffey?—Yes, but that is only a temporary arrangement.

13319. (*Colonel Harding.*) Have you the samples with you? No, I understood the Commission would have an opportunity of seeing the effluents and the places from which the samples were drawn.

13320. To what extent are there suspended solids in the sewage?—I did not determine them.

13321. Are your samples as pure as that before us from the Rainsford Street sewer?—Not quite—none of them are so limpid as that.

13322. Then your samples are alkaline? Yes.

13323. But not very strongly alkaline?—No.

13324. Sometimes they are discharged at a fairly high temperature I notice?—Never above 100 degrees.

13325. Then what becomes of your refuse, for you must get a quantity in the ordinary brewing operation?—We try to waste as little as possible—do you mean refuse beer?

13326. No, I mean spent malt?—The spent malt is all sold—if we cannot sell it in the wet state, we dry it, and store it; we don't let any of it go.

13327. Then practically no solid matter goes into your drains?—Practically none, I think the only solid matter one can give a definite name to is flue dust. I have seen flue dust in one of the samples.

13328. Is that from the malting?—No, it is from the boilers.

13329. But you have nothing in the shape of pot liquor, such as distilleries have?—No, the nearest approach to that is the washing of the vats, and you notice that one of the samples did contain that, but it is so immensely diluted—for every gallon of beer we use 5½ gallons of washing water, and as the waste on the beer is a small percentage, it is diluted enormously.

13330. (*Mr. T. J. Stafford.*) Have you got the chemical composition of the various samples there?—No, I had not time to give that, but their general character is shown in the general description of what they are.

13331. Do you discharge your sewage equally, or do you discharge it in great rushes at times?—We discharge it pretty evenly, for the maximum is not much above the average.

13332. But you empty the contents of great vats at times, and does that not cause a rush of sewage?—No, the maximum quantity is due to what is called the saving of the coppers. The coppers would burn if they were emptied. We have 225 barrels of water to the copper, and as soon as the last worts are run out the water is run in. This saving remains in the copper overnight, and we calculate we might discharge in the morning five or six coppers at a time. That is the way the figure is calculated; they all rush together, and that is when we have the greatest flow.

13333. What is the minimum quantity in any one hour—does it differ much from the average?—No.

13334. You don't use Vartry water to a great extent?—No, about a quarter of a million gallons only in the 24 hours, which we use for house supplies and boiler feed.

13335. You take your water from the Grand Canal, which is much harder?—Yes, very much harder.

13336. (*Dr. J. Burn Russell.*) What use is made of the dry refuse you sell?—It is used for feeding pigs and cattle.

13337. It is used for feeding purposes by dairymen?—Yes.

13338. You get quite a ready sale for that?—Yes, and any we have not a local demand for, we dry and send through the country. We supply the local demand to a large extent with wet grains, and what is over we dry and send through the country, and it is used for feeding purposes entirely.

13339. (*Chairman.*) There are some distilleries in Dublin?—Yes.

13340. Do they turn out pot liquor?—I don't think I can speak of that.

13341. Are they large compared with you, or comparatively small?—Comparatively small.

13342. (*Colonel Harding.*) Can you put in a typical analysis of the effluent you turn out?—It would be extremely difficult, because in different parts of the brewery we have different kinds of plant and different kinds of operations going on—one part has boilers, another part is a store house, and so on. For example, we get nothing but slightly oily water from the boiler houses.

13343. But it would be important to see what sort of effluent is turned out of a great brewery like yours. Would it not be possible to give an average analysis? You say you have taken samples from different outfalls; Could you not put them together and give the average?—Yes, that might be done.

13344. Would they contain an important amount of organic matter in suspension or solution?—Yes, I am afraid they would.

13345. (*Chairman.*) You could probably give us the samples, and let them be analysed?—Yes.

13346. (*Mr. T. J. Stafford.*) The brewery extends over a very large area?—Yes.

13347. There are discharges from the sewers of the different departments and it would be difficult to get a sample such as Colonel Harding wants?—Yes. Perhaps it would be better to get a complete analysis of the different discharges.

13348. The brewery is separated into different departments?—Yes.

13349. (*Colonel Harding.*) There would be no objection to the mixing of them for the purpose of analysis, because there is ultimate mixing, for they all go to the main outfall?—There would be no objection.

13350. (*Dr. T. J. Stafford.*) Is there much solid residue?—No.

13350* Could you give a guess at the amount?—No, I should not like to.

13351. (*Dr. J. Burn Russell.*) What is the total area of the brewery?—42 acres.

13352. (*Mr. T. J. Stafford.*) I presume you could give the samples the Chairman has asked for, with the permission, of course, of the directors?—Yes.

13353. And you are willing to do that with their permission?—Yes; but, of course, I should have to get their permission.

FORTY-FIFTH DAY.

TOWN HALL, BELFAST.

Thursday, 31*st July* 1902.

PRESENT:

Colonel T. W. HARDING, J.P. (*Chairman*).

Dr. J. BURN RUSSELL. | Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary*.

ALSO PRESENT:

Dr. A. C. HOUSTON. | Mr. COLIN C. FRYE.

Mr. J. C. BRETLAND, called; and Examined.

Mr. J. C. Bretland.

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13354. (*Chairman.*) You are, I think, Mr. Josiah Corbett Bretland, City Surveyor of Belfast, and Member of the Institute of Civil Engineers?—Yes, sir.

13355. Can you tell us when your present system of sewers was laid down?—I suppose you mean the main drainage or intercepting sewers?

13356. Yes, certainly. I take it that in the first instance they went right to the river?—They did, sir.

13356*. And when did you introduce that system by which these various minor sewers were intercepted by the mains?—I should say immediately after the passing of the Act of 1887, the local Act, the main drainage Act.

13357. When was the system of intercepting sewers first in operation?—It came gradually into operation.

13358. When was it in full operation?—About five years ago, I think.

13359. Then we may take it that before 1887 the sewage of Belfast went direct into the Lagan?—It went directly into the Lagan, almost all except one or two streams, practically the whole went in.

13360. Then what led to your introducing the intercepting sewers; was it a condition of nuisance in the river?—Yes, a terrible nuisance; there was a very bad stench and much filth.

13361. Then the effect has been to purify the Lagan?—It has had a very marked improvement upon the condition of the Lagan.

13362. Are there pollutions of the Lagan above Belfast?—There is practically no pollution of the Lagan until you get to the town of Lisburn, which is several miles out.

13363. Then is it fairly pure?—Yes, the river is fairly pure, trout are caught in it.

13364. So that the acute difficulty locally has been done away with?—Yes, that is so.

13365. And that has been in full operation since 1895?—The outfall works were in use before then. I suppose it is about five years ago. There are still branches going on. Only recently I have just completed, in conjunction with my assistant, Mr. Napier, a branch into newly developed property.

13366. And you have no sewage going direct into the Lagan now?—Practically none.

13367. And the condition of the Lagan ceases to give trouble?—We have practically no complaints. The only complaint we hear of is as regards impurity in the river, maybe confined to the immediate local neighbourhood of the junction of some of the manufacturing streams which go into the Lagan, and although the sewage has practically all been taken out by a very difficult and costly process there is still manufacturers' refuse, offensive matter, in these streams which come from the thickly settled manufacturing districts. Of course, in these cases we cannot expect, and, I fear, never can expect, limpid water.

13368. These sources of pollution, are they external to the city?—No, there are some in the city, some manufacturing products, go into these streams.

13369. Is there no suggestion at all that this should be taken into the sewers?—Yes, there have been several couplings up with our sewers, but some of the sources of pollution are not coupled up.

13370. Is no objection made by your Corporation to the reception of trade effluents into your sewers?—I should say that unless in some exceptional cases they would not.

13370*. And if you found it necessary, you are in the position of being able to lay down conditions before you agree to receive trade effluents into your sewers?—I suppose so, sir. I presume so.

13371. Then tell us, has the removal of your outfall sewage from the Lagan down into the Lough done away with all difficulties in connection with the sewage in this neighbourhood, or has any other difficulty arisen further up?—It is complained by residents on the foreshore that the seaweed in the warm months, accumulating in large heaps along the high water mark, is more or less obnoxious, and it is contended that in regard to a large portion of the seaweed, its growth is fostered by the fact that the Belfast sewage is discharged into the Lough.

13372. Have you been able to trace any sewage matter, especially in regard to suspended solids, on the foreshore?—I don't think so; I can hardly say.

13373. Then no appreciable difficulty has arisen?—In large tracts of what are called slob lands the tidal flow leaves a large expanse at low water, which in my own recollection was thickly covered with offensive sludge, but now it is possible to walk upon them at low tide.

13374. In regard to direct nuisance from turning sewage into the Lough, no appreciable difficulty has arisen, no direct appreciable difficulty?—I think not.

13375. What is the distance from your outfall to the sea?—What do you refer to, sir?

13376. The length of the Lough is quite considerable?—Yes.

13377. What is it—about 15 miles?—About 13 I should say, and three or four miles wide.

13378. Has the sewage time to get into the sea currents before the tide returns?—Yes, we get it out on the ebb tide.

13379. Then does it really get out to sea?—Well, it would get out to sea, but certainly not the 13 miles. Part of the sewage may come back, but in such a form of dilution that it can do no harm.

13380. The only difficulty, then, that has arisen is the complaint of people residing along the shores that this seaweed—the ulva latissima, I think it is—grows in large quantities, and is deposited along the shores, and that its growth is due to the discharge of sewage?—Yes, during the hot weather.

13381. It is not the living weed?—No, it is the decomposing weed. Where it is allowed to gather in heaps on the foreshore, then it is offensive. As an illustration of that I may say that when the warmer months are absent, say from November to May, we never hear a word of anything offensive on the shores of the Lough. It is only from about the first week in June to the middle of October that complaints are made.

13382. In the presence of those complaints your Corporation has taken expert advice?—They have, and are still taking it.

13383. Has the Corporation satisfied itself that that solution is the correct one, that the growth of this weed is due to the presence of the sewage?—I think that is conceded upon all hands. It is my own opinion that the growth of the ulva is fostered by the fact that sewage is present in some form. That coincides with my own observation, and as I live down upon the shore myself, I have observed it frequently.

13384. Can you tell us what your Corporation is proposing to do with a view to minimising this evil? In the first instance tell us what has been done; I take it that the outfall has been carried out as far as possible?—It is carried out to the pumping station which you saw yesterday, and then there is a wooden covered trough a mile in extent to convey it.

13385. A mile beyond that?—Yes, sir.

13386. And it is at that point that it goes into the sea?—Yes, it was constructed about 14 or 15 years ago, but the trough being of timber I should not like to describe it as being absolutely watertight, and, indeed, there is no doubt that there is considerable leakage. It was at first intended to have iron pipes, but the Corporation were advised to try wood. With the system of purification which the Corporation are undertaking, if the system goes on, we could discharge at all times of the tide. I mean the effluents produced would be fit for discharge at any place and at any time.

13387. Then you have storage—tanks or what?—Yes, we have storage reservoirs. I designed and constructed one for the Corporation with a capacity of 5,000,000 gallons, and it was built under the most exceptional circumstances. As a storage reservoir it has become quite too small. It was designed to amply suit the city of Belfast in 1887.

13388. How is it divided, into two tanks?—Into three compartments. The drawings can be laid upon the table.

13389. Did you say three compartments?—Yes, sir, three.

13390. What does your Corporation propose to do to reduce the evil complained of?—What the Corporation did after arranging—under the Act of 1899—to introduce a system of purification for the sewage of the city was, they asked me to make a report upon the matter. The first thing that happened then was, a few gentlemen, members of the Corporation, and myself, went across the water, because at that time we were rather ignorant of what was going on in other places, and when our attention was drawn to the fact that we had to move in the matter, we inspected several places across the water. The deputation presented a report, which I wish to hand you in, sir. (The witness here produced the report of the deputation appointed to visit various cities, with a view of obtaining and reporting on the latest information upon the bacterial method of sewage purification, dated April, 1899.)

13391. Upon that report was a scheme suggested by you to the Corporation?—Yes, but it was not until May, and I was then instructed by the Corporation to lay down some experimental bacteria beds, and I told them I would do my best. They supplied me with men, money, and material, and I made a set of four experimental beds, those you had an opportunity of seeing yesterday. I hope that those four experimental beds will not be merely experimental, and I hope to make them part of the scheme.

13392. You intend them to be permanent beds?—That is my intention.

13392*. Then, in making these experiments, are they based upon a definite scheme? Has any application been made to the Local Government Board to approve of the scheme, and to sanction borrowing powers?—Yes, in May, 1900, I presented a report to the consultative committee appointed by the Corporation to consider sewage purification regarding this question.

(*Here the witness produced the "Report of the City Surveyor to the Consultative Committee appointed re sewage purification, dated May,* 1900.")

(*Witness*) The substance of that report is the recommendation of a scheme for the purpose on the lines of the open bacteria beds.

13393. Double contact beds?—Yes, exactly; but so arranged that when an increased flow from rainfall takes place they can be used for one contact.

Mr. J. C. Bretland.

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13394. To be able to deal with the sewage on a single contact?—Yes.

13395. Without any previous treatment?—Yes.

13396. Was it proposed to have any sedimentation?—Nothing further than our present reservoir. I always maintain and still maintain that the Corporation of Belfast, owing to the surroundings—the tidal surroundings—would hardly be justified in spending double or treble the amount of money representing that scheme, for the purpose of producing a superfine effluent as I may call it, which would be reasonable and necessary for an inland town like Manchester, Sheffield, or Nottingham.

13397. Then you are further experimenting?—Yes. I got instructions some nine months ago to go on and construct a further set of beds.

13398. In accordance with the same settled plans?—Yes.

13399. Has that been before the Local Government Board?—Yes.

13399*. And approved?—Yes, the finding, as I understand it, is this: A sum of £80,000 is required to be expended by that scheme. Mr. Cowan, the Local Government Board inspector, sat in this room, and the issue of his inquiry is that the Board have given the Corporation liberty to borrow £50,000 for the present, and they say that that scheme, the lines of that scheme, are the right lines to move upon. With regard to the effluent which has been produced, they think it would be advisable that we should try to do something better. I don't know, but I rather fancy that is what they have in their minds. It was given in evidence by Dr. Letts that there were certain chemicals in the resultant effluents given out which fostered the growth of the weed ulva latissima, although it was perfectly fit to be put into deep water if there were no weeds. The Local Government Board think we should see whether that evil—if there be one—cannot be cured. If some means can be found to change the nature of that effluent in such a way as to prevent the growth of the weed, that would solve the difficulty. Dr. Letts has made experiments, and I believe he will tell you that he has an opinion upon the matter that something might be done to deal with the effluent by means of the growth of the weed itself in a confined area.

13400. Will you tell the Commission what is the character of the scheme you propose to carry out and put before the Local Government Board? Is it double contact beds which might be used as single contact beds when necessary?—Yes, during heavy storm times there is an arrangement by which it can be run into the Lough direct; the Corporation have power to do that.

13401. What is the total area of the beds?—About 15 acres.

13402. What quantity can you deal with?—I think about 260 gallons per square yard.

13403. A little over a million gallons per acre?—Yes.

13404. We may take it, Mr. Bretland, that although that scheme has been submitted to the Local Government Board, it is not being carried out except in a tentative way? You are carrying out certain parts which may be made permanent if desirable?—Yes.

13405. Are you satisfied that the method you propose to adopt is likely to be successful?—Yes, I am strongly of opinion that we are on the right lines. If it may be supplemented, so much the better, but I think the Local Government Board agree that we are on the right lines.

13406. And you have taken expert advice?—Yes, that of Dr. Letts and Dr. Lorrain Smith, and I understand they will place before you the result of their researches.

13407. Then you would prefer in regard to the growth of the weed that we should examine them?—Oh, yes, certainly.

13408. (*Mr. Stafford.*) About the pollution of the Lagan, there is a certain amount of pollution still going on?—Well, I consider it very trifling.

13409. What is the report you handed in?—The report of the deputation of April, 1899.

13410. I see there that it is stated: "Nearly all the sewage of the city under the control of the Corporation has been diverted from the Lagan and its contributory streams. It is to be regretted, however, that the sewage from the Harbour Estate, including fæcal matter produced in consequence of the employment of thousands of

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workmen and others employed in the shipping industry, is still discharged into the river." Does that still discharge?—Yes, I was speaking of the Corporation's duty. It is a fact that there is a source of pollution from the Harbour Estate, I regret to say.

13411. That nuisance still continues?—Yes.

13412. Does distillery refuse discharge into the river?—No, it discharges into the sewers. There may be some of it which gets into the Connswater River, but generally it discharges into the sewers.

13413. Have any difficulties arisen between the Corporation and the distillery owners? There has been correspondence?—Yes. It was with the Public Health Committee.

13414. Has there been a considerable amount of correspondence?—I think there has.

13414.* The Public Health Committee have complained about the character of the effluent discharged?—Yes, I am of that opinion, but the Public Health Committee will give you that.

13415. About the Act of 1899, it was to a large extent a tramway Act? It was a sort of omnibus Act?—Yes. It was promoted for drainage purposes also.

13416. Yes. I see that in section 44, sub-section 6 provision is made that "the Corporation shall within three years from the passing of this Act provide works and appliances necessary for the proper purification of the sewage of the city of Belfast discharged from the system of works authorised by the Belfast Main Drainage Act, 1887, and shall efficiently work the same. The system of treatment and method of putting the same into operation adopted by the Corporation shall be subject to the approval of the Local Government Board." It is under that provision you acted recently in submitting your plans to the Local Government Board?—Yes. It is no secret to say they are a little behind the time, but it is done I have no doubt with the very best object. We did not rush in hastily before we had seen what was the best course; we wanted to go on the soundest lines.

13417. Can you tell us the local circumstances under which that provision was inserted in the Act?—Oh, yes, I was up in London at the time the Act was going through. There was a good deal of complaint at the time about the discharge of sewage into the Lough. There was a consultation between those who complained and the Corporation, and the Corporation themselves were not unwilling to move; they always had the intention under the circumstances of the case, and when the financial state of the Corporation would justify them in starting something of this kind, to do so. If you refer to my report of 15 years ago you will find it all foreshadowed. I said that when the time had come we should try to do something in the way of purification of sewage. At that time it was thought that chemical treatment was the only way of dealing with it, and we were frightened at the expenditure. But land was taken, and some of it is still to be enclosed, some 70 acres were acquired by the Corporation for the avowed object under the Main Drainage Bill.

13418. And this particular provision was the result of pressure from outside?—It was the result of pressure from the outside, but the Corporation did not contend much against that pressure, because they were anxious to do something themselves.

13419. While the complainants from outside complained on account of the pollution of the foreshore?—There were the elements of the Harbour Estate, and also the foreshore element. The Corporation were not at all unwilling to tackle this thing. They thought the time had come to move, and so they gracefully—may I say?—consented to that clause being put into the 1899 Act.

13420. And it was on account of the growth of this weed, this ulva latissima that the nuisance arose?—Yes, chiefly on account of the growth of that weed. That was the means by which any nuisance could arise. No weed, no smell, no complaint.

13420*. (*Chairman.*) It is an indirect difficulty?—Yes, sir.

13421. (*Mr. Stafford.*) How much of the foreshore is under the County Borough of Belfast? How much is in their district? Up to Holywood?—No, sir. As far is Tillysburn on the one side, and as far as Greencastle village on the other is under their control. They also own a piece of the foreshore for a short distance on the County Antrim side.

13422. So that a good portion of the foreshore polluted is in the hands of the Corporation themselves?—Yes, under their control as the sanitary authority.

13423. These portions were taken in when the boundary was extended?—Yes, the recently extended area of the city in 1896.

13424. In the Act of 1899 in the Section (44) I read, it says, "Within three years of the passing of this Act." How far have the Corporation got now in obeying that Section?—Well, another instalment of the work is practically executed; it will be finished in two or three weeks.

13425. But you are not yet asking the approval of the Local Government Board under that section to the work which you have carried out. "The system of treatment and method of putting the same into operation shall be subject to the approval of the Local Government Board." Are you in that position now to ask for approval?—To the general scheme, yes. "The system of treatment, and method of putting the same into operation." The Local Government Board have expressed themselves generally satisfied with the scheme, but have reserved the right of adjudicating upon the effluents upon a future occasion, hoping that we should be able to improve the effluent as we went along. When they gave us the loan they accompanied it with certain written remarks. I have not them here just at the moment, or I should desire to read them.

13426. Are you satisfied that the effluent produced at present is a good experimental effluent?—Yes, I think I am right in saying that according to Dr. Lett's percentage, the purification in the beds, that is as between screened and settled sewage, is something like 73 per cent., and while I am fairly satisfied I should like to see it better. But as I said before, I don't think that a large amount of money should be expended in Belfast, owing to our surroundings, in order to produce superfine effluent.

13427. But you want to produce an effluent, I presume, which will prevent the continued growth of this seaweed?—Yes. I should be very glad, and the Corporation of this city would be very pleased if something—if experiment shows that at anything like a moderate expenditure something could be done to prevent the growth of the weed. It was admitted at the inquiry that the works reduced the growth of the weed.

13428. Have any experiments been conducted which will show that?—Dr. Letts has made some experiments in his laboratory, I think.

13429. But it is generally admitted that the cause of the nuisance on the foreshore is the presence of this weed?—Yes, as I say, no weed, no smell, no complaint.

13429*. And any system which does not prevent the growth of this weed would not be a satisfactory solution of the difficulty?—If it would be reduced 50 per cent. it would be partially satisfactory. I remember the prevalence of this weed ever since I came to Belfast, and it is certainly better now than at one period in my own recollection.

13430. Under the section of the Act of 1899, which I have read, the Corporation are required to produce an effluent which will satisfy the Local Government Board, but they were not bound to stop the growth of the weed?—No.

13431. You are not bound to stop the growth of the weed?—No.

13432. But to so purify your sewage that it will not be the same nuisance as in the past?—I should not say we are exactly bound.

13433. Is not the weed the source of the whole nuisance?—Yes, I think so.

13434. Then no system would be satisfactory which does not destroy the growth of the weed?—Not perfectly.

13435. And therefore you would have a continuance of this nuisance unless the weed does not grow in Belfast Lough?—Yes, it is yet to be found out whether it will not stop the growth of the weed. We have only certain things yet which may be right or wrong. It is not outside the bounds of possibility to so reduce the growth of the weed that it would be quite satisfactory.

13436. Then you think it would be desirable to continue the experiments you have in view at present?—I do strongly, and I think some little breathing space should be allowed to the Corporation in their efforts to deal with this problem.

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13437. I should agree with you there. And the Corporation are pushing on and continuing their experimental works?—Yes, the men are there from day to day, and my great cry is "fill! fill! fill!" Of course if I got an order to go on at full speed I should get on much quicker.

13438. I was thinking more of the continuation of the experiments, the work of Professor Letts and Dr. Lorrain Smith. Is that still continuing?—Yes, it has been in abeyance for a short time, but an arrangement has been come to, to continue their experiments.

13439. And that is most desirable?—Yes, that is most desirable, and preparations have been made to accommodate them by means of a septic tank, and by beds being made for the growth of the ulva latissima.

13440-50. In your report of May, 1900, you say: "I confidently recommend the foregoing scheme to the favourable consideration of the Corporation, being convinced that it is the one best suited to the requirements of the city, aiming as it does at producing for a reasonable outlay, an effluent of sufficient purity to be discharged into the tidal waters of the Lough. Have you made up your own mind what the standard of purity should be?—I think the effluent is pure enough, amply pure enough for Belfast Lough, but retaining as it does the elements which still foster the growth, which provides, as it is said, the food for the weed, it would be desirable to do what we can in that direction also.

That will do, thank you.

(*Witness.*) I hope you will excuse me being verbose; it is rather difficult to explain.—No; I think you have been very satisfactory.

13451. (*Chairman.*) What is the normal flow, the dry weather flow, of water in Belfast?—I think you may take it at 11,500,000 gallons.

13451*. And what is the population?—350,000, practically.

13452. That is, 30 gallons, about, per head?—Yes, rather more than 30 gallons. Of course, during the hot weather there is a greater flow than that in the city, but a good deal of it does not come down to our works.

13453. What is your water consumption?—I think about 11,000,000 gallons.

13454. Something similar to the outflow?—Yes; but there is a good deal of water, manufacturing water, which does not come down to our works at all.

13454*. This is a water-closet town?—Yes, and any fragments of it that are not are rapidly becoming so.

13455. Then are there many privies left?—Well, I should say some 20,000, but they are being reduced month by month. Of course, all modern Belfast has water-closets, and all the newly-constructed houses have water-closets, even the working-class dwellings, and very largely they have baths as well.

13456. I see in your report there are a number of analyses by Mr. Barklie. They say screened and partly settled sewage; what is that?—It is the sewage as it goes out of the tank or large reservoir. I may say that the experiment we made is between that screened and settled sewage and the effluent; that was the range that gave 73 per cent. of purification. If it had been from the crude it would have been more.

13457. Can you tell the amount of sediment in these sewage tanks? When you are pumping, do you go on almost to the moment of discharge, or is the sewage tank full, and then allow the sedimentation to take place?—It is very difficult to say. We can fill the reservoir about 4ft. deep by gravitation, then we have to pump. The discharge takes place very soon after the cessation of the pumping.

13458. It will be stirred up by the advent of another influx, would it not?—I don't think to such an extent as you would imagine.

13459. But you find there is sediment? Mud does deposit?—Yes, it comes out in the rush, but a few times we have taken some of the more solid mineral matters out of the reservoir.

13460. Is it largely mineral deposit?—Yes, we have occasionally taken it out of the reservoir. It is all mineral matter.

13460*. Have you satisfied yourself that that is so?—To a large extent.

13461. Would there not be a large mixture of organic matter?—Yes, there is a fairly large amount of organic matter.

13462. These samples referred to by Mr. Barklie were taken from the upper water in the sewage tanks?—Yes, from the sewage tanks, not quite from the top, nor yet from the bottom; about 3ft. below the surface.

13463. There will be less suspended matter in it than in the absolutely crude sewage?—Yes, I think so.

13464. Has it occurred to your Corporation to set these matters so as to permit of their withdrawal and carried out to sea?—We should have, no doubt, some amount of sludge, and I have very little doubt that, coupled with a scheme of this kind, that is a thing we should have to take from time to time out of the reservoir.

13465. Then no experiments have been made for sedimentation only so far with a view to the removal of the sludge from the discharge?—No, except general observation.

13466. I was rather struck yesterday, in looking at the samples shown, to notice how little suspended matter there seemed to be in Mr. Barklie's analyses from the screened and partly settled sewage. There are in the first instance 25 and 26 grains of suspended matter. On page 18 it is 43 and 44 grains, on page 20 it is much less than that, only about 10 grains; on page 21 it is 44 grains. Is it intercepted anywhere?—No, it is not.

13467. Then what is really mixed up in the tanks is mixed up again and comes out there?—Yes.

13468. It might be worth the consideration of your Corporation that these matters might be kept permanently out of the outfall?—Do you mean as it exists now?

13469. Now it is sent out to some extent; these samples taken from the upper water, these matters taken away, are mixed up again by the rush and go into the seaway?—While we discharge crude sewage into the Lough I don't think the Corporation are bound in any way to collect that matter which goes out daily with the tide.

13470. But the Corporation is experimenting to minimise the growth of the ulva latissima. It might be worthy of consideration whether the withdrawal of these suspended matters might be effective in reducing the growth of the weed. You are not proceeding with these experiments just now?—Yes.

13471. You are free to experiment?—Yes.

13472. Your Corporation recognise how unique your position is. Double contact filtration does not necessarily guide you in this matter?—No, to some extent.

13473. Yours is entirely a unique difficulty, and may require uncommon methods?—Yes, as regards the weed.

13474. (*Dr. Russell.*) What is the Harbour Estate?—It is a large, wealthy, and valuable estate vested in the Belfast Harbour Commissioners, who are large proprietors on the northern end of the city.

13475. And within the limits of the borough?—Yes, I think so. They have control of land outside the city as a harbour authority for certain maritime purposes.

13476. With reference to the passage referred to by Dr. Stafford in your report of May, 1899: "It is to be regretted, however, that the sewage from the Harbour Estate, including fæcal matter produced in consequence of the employment of thousands of workmen and others employed in the shipping industry, is still discharged into the river." Have you made any efforts to get this enormous mass of fæcal matter into your intercepting system?—The Harbour Commissioners asked permission from the Corporation to allow them to discharge intercepting sewers into our system, and the Corporation expressed their willingness to allow them to do so; but up to the present, so far as I know, I am not aware of any practical steps being taken by the Harbour Commissioners.

13477. But I suppose you would look upon it as a very essential procedure?—Yes, I do.

13478. Can you give us any accurate estimate of the number of persons employed there, and who contribute to this nuisance?—I cannot say the exact number, but it is no infrequent thing to have 10,000 people employed in the shipbuilding firm of Messrs. Harland and Wolff, and half that number, say, in the shipbuilding yard of Messrs. Workman and Clark, on the other side of the river. I have no doubt that much of the solid matter does not go into the river, but much of it does.

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13479. Still you have the words of your own report. There is no doubt there is still pollution. Have you made any systematic attempt to gather together the manufacturers' pollution, so as to make a complete job of your scheme?—There has been a good deal done in that direction by the Public Health officers, who could give you lists. There are some waters got by manufacturers for their trade purposes, and the manufacturers dare not discharge the water anywhere else but back again into the river for legal reasons?—Yes, we are familiar with that aspect of manufacturing pollution.

13480. In regard to fæcal pollution the expenditure of a large amount of money has resulted for all practical purposes in its being diverted from these streams?—So far as our Corporation is concerned.

13481. (*Chairman.*) But are there no sources of fæcal pollution above you in the upper waters of the Lagan and the streams which flow into it?—There is no pollution of the Lagan above Belfast until Lisburn is reached, which is the first town. When the village of Ligoniel was included in the city boundary, one of the first things the Corporation did was to have designed a system, a branch, by which the sewage of that village could be diverted into our main drainage system. That work has now been completed. There are still some parts of the extended city, the supplementary schemes for which will shortly be undertaken.

13482. Prior to the construction of these intercepting works the Lagan was in a very offensive condition?—Yes, in a terrible state, with abominable stench and filth, and what it would have been now had not purification taken place I really cannot tell.

13483. Was it necessary to dredge in any way to keep up the fairway?—Yes, and there is still dredging.

13483.* There is still?—Yes, there is a large amount of alluvial deposit in the stream. I remember they used to dredge up black mud, but they now dredge up yellow sand.

13484. Then there has been an improvement in the character of the dredgings?—Oh, yes.

13485. You do not know anything about the quantity?—No, hardly.

13486. What do they do with the dredgings?—Take them out to fill up and make ground outside the limits of the city. There is always plenty of demand for the stuff. At present there are dredging and other operations going on in the Musgrave Channel.

13487. And you have noticed a great improvement in the character of the banks since you first knew them?—Yes, it is generally remarked. The chairman of my own committee of the Corporation would be able to tell you about that. The flats can be walked upon now; they are dry at low tide. It is now half mud and clay, alluvial deposit.

13488. Do you suppose that what is discharged at high water is carried out for the greater part to sea?—Yes, I think it is generally driven out.

13489. (*Mr. Stafford.*) How far is Lisburn from Belfast?—As the crow flies or along the river?

13490. Along the river?—The river is very tortuous.

13491. Approximately?—It will be nearly ten miles on the course of the river.

13492. What is the population of Lisburn?—I should say from 15,000 to 20,000.

13493. Does the whole sewage of Lisburn discharge without treatment into the Lagan?—I cannot answer that question, sir.

13494. Do you know if crude sewage is discharged into the Lagan?—I am under the impression that an amount of crude sewage gets into the Lagan.

13495. Can we get that information?—Yes; I think Dr. Letts will be able to give you some information in regard to that. It does not affect us in Belfast.

13496. You think it will not affect you, a population of 20,000, discharging their crude sewage into the river ten miles above you?—Oh, yes, of course. I think it would only be fair that neighbouring towns like Lisburn, if Belfast sets the lead, should follow suit.

13497. It would materially affect you if it did not?—Yes, it would.

13498. You say in your report of April, 1899: "The accumulated seaweed on the foreshore, which is allowed to decompose in the late summer and autumn, and which may to some extent be fostered in its growth by sewage from Holywood and other places along the shore, and perhaps by the sewage from Belfast, is no doubt very offensive to the senses. Hence the representations recently made by the residents along the Lough." Is there a large sewage discharge from Holywood and other places along the shore?—Yes, and from places like Cultra and Marino.

13499. Do all discharge upon the foreshore?—Yes.

13500. And it materially affects the growth of the weed?—Yes, I have not the slightest doubt about it.

13501. (*Dr. Russell.*) What is the population of Holywood?—About 10,000 altogether, I think; this is including those who live round about it. It is a large residential district, and there are in addition the barracks there.

13502. You referred to some instance of the offensiveness of this weed in Southampton waters?—I know Southampton pretty well, and I must say there is some offensive odour from the seaweed there, but I do not know if it is the ulva latissima.

13503. You think it seaweed of some sort?—Yes.

13504. (*Mr. Stafford.*) In regard to the loan, the application to borrow £78,000 for sewage purification works, can you give us the sense of the reply of the Local Government Board to the Corporation?—Yes, here are the exact words: "The Board are of opinion that while the general lines upon which it is proposed to treat the sewage before it is discharged into the Lough are satisfactory, it is desirable that a greater degree of purification than has been effected in the experimental works should be secured. In the meantime, therefore, while the Board now sanction borrowing to the extent of £50,000 for the construction of purification works, they will defer their formal approval under Section 43, Subsection 6, of the Belfast Corporation Act of 1899 until further investigations have been made and reports furnished by experts." Those are the words.

13505. (*Chairman.*) Just a final question. Would you agree to this summary of your evidence? Before your intercepting sewers were constructed there was a very serious pollution of the Lagan; your intercepting sewers have practically done away with the evil; that by the discharge of crude sewage matters into the open Lough no direct evil has arisen from such discharge; that sewage matters are not found on the shores of the Lough, but there appears to have been an increased development of the ulva latissima, which brings about by its decay a serious nuisance, a nuisance alleged to be due to the presence of sewage matters in these waters?—Yes, but I should like to qualify that; a nuisance to the senses, but not really detrimental to health.

13506. It is claimed to be a serious nuisance?—Yes.

13507. Your Corporation recognises its responsibility to avoid taking any course which would promote the growth of the ulva, and is carrying out a series of experiments for the purpose of dealing with the sewage so as to minimise that growth?—Yes, believing that the way they are doing that will be common to everything in the final scheme. They will still be utilised in any further development. One word, as regards Lisburn. It is quite possible that the water chemically may be such as to contribute to the growth of the weed.

13508. Has any analysis been made?—No, I don't think so of the Lagan.

13509. I don't think it will be necessary for us to trouble Mr. Napier to-day; we had considerable conversation with him yesterday, and I don't propose to trouble him to give evidence?—As you please, sir.

Dr. E. A. Letts.

Dr. E. A. Letts, called; and Examined.

13510. (*Chairman.*) You are Dr. E. A. Letts, Professor of Chemistry in the Queen's College, Belfast?—Yes, that is so.

13511. I think you have given considerable attention to the question as to how far the presence of sewage matters in the Lough waters promotes the growth of the ulva latissima?—Yes, I have.

13512. You have been consulted upon that point by the Corporation of Belfast, and possibly by other local authorities?—Yes, that is so.

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13513. I suppose we may take it that the ulva latissima existed on these shores apart from sewage pollution, that the probability is that it does not owe its presence there to sewage pollution, but that its excessive growth is due to the pollution?—Yes, its excessive growth, in my opinion, is due to pollution.

13514. Can you tell the Commission by what process you have come to that conclusion?—I have prepared a statement in writing, Mr. Chairman; I think it might take from a half to three-quarters of an hour to read.

13515. Will you hand it in?—I would prefer it to be taken down. I would suggest I read it; it deals with the whole subject.

13516. You think it would save time if you read it?—Yes, I do.

13516*. All right?—In the first place in order to preserve a line of continuity, between my past evidence and the present—I would ask your permission to give a brief resumé of my past evidence, then to tell the Commission what work I have done since of a scientific and practical nature, and lastly the work which I hope to do in the future. As regards the evidence given in the past by me, part of it relates to the growth of the seaweed, the ulva latissima, and the conditions attendant upon that growth. I was led to that subject from a study of the nuisance which arises from the Lough in connection with the weed—a nuisance, sir, which I think you saw the potentialities of yesterday, without being able to realise the actual condition of the nuisance as it sometimes occurs when the weather is extremely warm and large quantities of the weed are deposited, and frequently remain more or less stationary in the shallow pools and bays along the coast for miles. Under these circumstances putrefaction occurs very rapidly, and a perfectly intolerable stench arises, which is perceptible over a wide area, and is sickening at the actual site of the nuisance. It was in this way that I became interested in the ulva latissima, and, together with Mr. John Hawthorne, my pupil, I made a somewhat extended inquiry on the seaweed, which embraced not only a study of the chemical changes which occur when it ferments, but in addition an examination of the composition and characters of the weed itself, and its relation to the pollution of sea water by sewage. We proved experimentally that when it is closely packed in sea water it rapidly putrefies—if the mixture is kept warm—and that eventually all the characteristics of the foreshore nuisance are produced in miniature. At first a fermentation occurs, and carbonic anhydride and hydrogen are evolved in abundance, while certain organic acids (mainly propionic, butyric, and some acetic acid) are simultaneously produced from the tissues of the weed. Later a second change occurs, in which what remains of the weed from the first fermentation blackens and sulphuretted hydrogen is evolved. The peculiarly offensive and sickly smell arising from the foreshore of the Lough in warm weather is due to this latter gas in conjunction with the fatty acids. The chemical changes which the seaweed suffers, whereby these substances are formed, are caused by certain micro-organisms, and from our experiments on this point we believe that at least two different species attack the weed. One of these appears to infest the seaweed itself, and causes the production of the two gases, carbonic anhydride and hydrogen, along with the organic acids. The other, we have some evidence for believing, is derived from the mud of the foreshore, and causes the evolution of the sulphuretted hydrogen and the blackening of the seaweed by the production of sulphide of iron. Our next experiments were made with the object of studying the relation of the ulva latissima to sewage pollution, and the evidence which we eventually collected tending to prove that the occurrence of this seaweed in quantity in any locality is associated with the pollution of sea water by sewage was of three kinds. First, that afforded by the composition of the weed itself, or rather by the amount of the nitrogen which it contains, analysis showing that when dry the quantity of that element amounts to 6·2 per cent. of the weight of the weed, which, multiplied by the usual factor, 6·25, gives the extraordinary figure of 38·6 for the percentage of albuminoid substances in its tissues. This is greatly in excess of the quantity present in any other seaweed, and in vegetable products generally; and indeed in this highly significant feature of excessive nitrogen content ulva latissima is more allied to an animal substance than to one of vegetable origin. Secondly, we contrasted localities we were acquainted with in which ulva latissima occurs in quantity with others from which it is virtually absent. In Dublin Bay the conditions under which the ulva latissima occurs in quantity are both interesting and significant. Broadly speaking, the upper reaches of the bay are divided artificially into two portions by the so-called Pigeon House wall, which extends for more than a mile and a half in an easterly direction, and terminates in Poolbeg Lighthouse. A second wall, called the North Bull wall, juts out from the northern shore of the bay at Dollymount, and extends in a S.E. direction to within about 1,000 feet of Poolbeg Lighthouse, terminating in a second lighthouse called The Bull. The northern part of the bay thus almost enclosed by the two walls forms the harbour; on the other hand the southern portion of the bay is quite open. The harbour receives not only the waters of the Liffey river, into which the major portion of the city sewage at present flows, but also those of the Tolka river, which is polluted by a large sewer running into it close to its mouth, while another large sewer discharges directly on to the northern shore close to the city, as well as a considerable number of smaller sewers the whole way thence to Dollymount. On the other hand, no sewers of any magnitude (if, indeed, any at all) discharge their contents into the southern portion of the bay until Blackrock and Kingstown are reached, which are quite at its mouth. Thus, broadly speaking, the northern portion of Dublin Bay consists of a polluted area, while the southern portion is unpolluted. Now, plenty of ulva is found on the northern shores of the harbour, and is washed up along the Clontarf foreshore, where, as in Belfast Lough, it rapidly putrefies in warm weather, and gives rise to a nuisance. On the other hand, the southern portions of the bay seem to be quite clear of the seaweed until Blackrock and Kingstown are reached, where it is found in fair quantity, and there a sewage tank discharges its contents into the sea.

Belfast Lough.—According to the statements of some of the older inhabitants of the neighbourhood, ulva latissima was not present in former times in the very large quantities in which it now occurs in the upper reaches of the Lough, but the zostra marina, or sea grass, now found only in small quantities, was abundant. Up to the year 1889 the bulk of the sewage of the City of Belfast was allowed to flow directly into the Lagan river, but in that year a new drainage system was inaugurated by which the greater part of the sewage is collected into two main channels, and from them pumped into a tank, the contents of which are discharged (on the ebb tide only) through a submarine culvert opening some distance seawards. Belfast, as everyone knows, has grown with remarkable rapidity, and there can therefore be no question that for that reason alone very much more sewage makes its way into the Lough now than formerly, and this amount has undoubtedly been increased since the introduction of the main drainage scheme, the Lagan river no longer acting as a settling tank in which the bulk of the sewage solids was deposited. The tides in the upper reaches of the Lough are sluggish, and it is probable that a considerable portion of the sewage, if not indeed the greater part, does not make its way out of the Lough on the ebb tide, but having drifted a certain distance seawards, is washed backwards by the flood tide in a bifurcating stream, which distributes it over a wide area.

Strangford Lough, which is quite close to Belfast Lough, resembles the latter in extent of area, and also in the large surfaces uncovered in its upper reaches at low water. It differs from it, however, in that no large town is situated on its banks. In this Lough ulva latissima is practically absent. Moreover, to the best of my knowledge, ulva never occurs in quantity at any spot on our coasts removed from the influence of pollution.

These facts seemed to offer strong *primâ facie* evidence that the growth of the ulva latissima is associated with pollution of sea water, and, as a consequence, that its occurrence in quantity in a particular locality may be regarded as an indication of sewage pollution. This view received very remarkable confirmation from experiments which we made on the power which the seaweed possesses of absorbing inorganic compounds of nitrogen, such as ammonia and nitric acid, from polluted sea water—that is to say, those simple compounds which the nitrogenous constituents of sewage are eventually converted into by any system of disposal, whether natural or artificial,

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if I may use the expression. Since last giving evidence before the Commission, I have, along with Mr. Hawthorne, made further experiments on this subject, with results that I can only describe as startling, and with your permission I should like to describe them. The seaweed we employed had been somewhat roughly treated. Originally collected near Dublin, the fronds were rolled into packets which were placed in a sponge bag and sent by post to Belfast. By an accident they were left uncared for on their arrival for more than a week, and when examined several of them were found to be in a state of incipient decomposition. Some, however, appeared to be still healthy. These were well washed in tap water, trimmed with scissors (for cutting the seaweed does not appear to affect its vitality), and the pieces placed in fresh sea water in glass dishes. The experiments on their powers of ammonia absorption were made six or seven weeks after they had been collected, and they are still alive, although a year has elapsed, and they have had no change of sea water. Two different series of experiments were made, the first with a solution of a pure ammonium salt in sea water, and the second with a mixture of sea water and the effluent from the bacteria beds (after double contact). All the experiments in the first series were made with the same piece of seaweed, which had an area of about 200 square inches, and a similar remark applies to the second series, in which, however, several pieces of seaweed were used, having a total area of about 600 square inches. Individual experiments were made in both series to test the absorptive power of the seaweed in relation to concentration (of the ammonia) as well as the effects of light and darkness. The following table gives the chief results obtained:—

ABSORPTION OF AMMONIA BY THE SEAWEED *ULVA LATISSIMA*:—

(A) FROM A SOLUTION OF AMMONIUM CHLORIDE IN SEA WATER.

(Area of Seaweed 200 square inches.) (Volume of Mixture 2½ litres.)

Parts of Ammonia per 100,000 of Liquid originally present.	Percentage of Ammonia absorbed after					In
	1 Hour.	2 Hours.	3 Hours.	4 Hours.	5 Hours.	
0·085	59	81	91	—	—	Daylight.
0·18	58	88	96	97	—	Daylight.
0·085	37	77	87	91	—	Darkness.
0·96	29	44	56	67	73	Darkness.

(B) FROM A MIXTURE OF BACTERIA BED EFFLUENT AND SEA WATER.

(Area of Seaweed 600 square inches.) (Volume of Mixture 2½ litres.)

Parts of Ammonia per 100,000 of Liquid originally present.	Percentage of the Ammonia absorbed after					In
	1 Hour.	2 Hours.	3 Hours.	4 Hours.	5 Hours.	
0·084	64	82	91	—	—	Daylight.
0·412	59	86	96	98	99	Daylight.
0·080	18	45	58	—	—	Darkness.
0·095	58	79	87	94	96	Darkness.
0·532	43	63	73	78		Darkness.

The general conclusions which we drew from the experiments are as follow:—

(1) The absorption of ammonia by the seaweed is very rapid, and with the mixtures used practically all the ammonia was absorbed in five hours.

(2) The amount absorbed is greatest during the first hour of contact, and then rapidly falls off.

(3) Although the concentration of the ammonia exercises some effect on the proportion absorbed, it is by no means so considerable as might have been expected.

(4) The seaweed absorbes ammonia both in daylight and in darkness, but the proportion in the latter case is rather less than in the former.

(5) The effects of an increased area of the seaweed on the proportion of ammonia absorbed are not so great as might have been expected.

And our experiments may also furnish a hint as to a possible new method of sewage treatment by what I may term aquatic sewage farms. I should like to take the opportunity of here mentioning another property of the ulva, viz., its remarkable powers of oxygen evolution and carbonic anhydride absorption.

Again and again in our experiments we noticed the curious stimulating effects of the added ammonia or effluent, which were evident from the rapid evolution of oxygen from the surface of the seaweed which always occurred about 15 minutes after adding the polluting substance to the sea water, and, indeed, forms a pretty lecture experiment. In two cases the dissolved gases were extracted from the sea water in which the ulva was immersed (by boiling out with dilute sulphuric acid in vacuo) immediately after adding the polluting material and again some hours later, and the gases analysed. The first experiment was made in daylight, and it was found that after four hours the carbonic anhydride had diminished by 5·79 c.c. at N.T.P. per litre, while the dissolved oxygen had increased by 3·43 c.c. at N.T.P. and about 2 c.c. of evolved oxygen were caught in a special arrangement. The second experiment was made in darkness, and showed, as was to be expected, a reversal of the phenomenon, the mixture of sewage effluent and sea water having gained 2·85 c.c. of carbonic anhydride with nearly the corresponding loss of oxygen, viz., 2·46 c.c. From these results the reason for the well-known fact that a few fronds of living ulva keep a marine aquarium healthy is clear. Not only is it an admirable scavenger, but it supplies an abundance of oxygen, and, indeed, I may mention that in the above experiment made in daylight the quantity of dissolved oxygen eventually found was nearly three times the amount which Dittmar found that sea water would absorb from constantly renewed air. Now it so happened that while our work on the seaweed was in progress I was anxious for purely scientific reasons to study the changes which occur in mixtures of sewage and sea water, and an experimental investigation was accordingly made on the subject by myself, in collaboration with Messrs. Blake, Caldwell,

and Hawthorne, and afterwards continued by Mr. Hawthorne and myself. One of the results of this work was to show that under aerobic conditions the change of the albuminoid matters present in the sewage into ammonia and eventually into nitrate occurs very slowly—so slowly, in fact, that with mixtures containing 1 per cent. of sewage, the first of these two changes has only proceeded to a slight extent after some weeks, while the second is incomplete after some months. At the time of making these experiments it did not occur to me that they would be of any special value in relation to the growth of the ulva latissima, and the problem of sewage disposal at Belfast, but the importance of the results obtained soon became obvious after I had ascertained the extraordinary power the seaweed possesses of absorbing ammonia and nitrates from sea water, and that its tissues contain so high a proportion of nitrogen, and had also learned that the scheme of purification proposed for Belfast was treatment by bacteria beds. For the albuminoid matters present in sewage are eventually converted into ammonia and nitric acid (or, at least, are supposed to be), and the albuminoid matters themselves are, as is well known, by no means entirely removed from sewage by treatment on bacteria beds.

If then the albuminoid bodies still present in the effluent change rapidly into ammonia or nitrates on dilution with sea water, a store of what may be termed potential food for the ulva will flow into the Lough in addition to the actual nourishment which the effluent contains in the shape of ammonia. On the other hand, if the conversion of the albuminoid matters occurs very slowly, they will eventually escape seaward without furnishing nourishment for the ulva, as the latter is incapable of absorbing them in the unchanged condition. The experimental results obtained appear to decide the question, the change of albuminoid bodies into ammonia, and the further oxidation of that substance to nitrate, occuring so slowly that their effect on the growth of the ulva latissima may be disregarded.

About the time we were making these experiments the attention of the municipal authorities in Belfast had been directed to the condition of the Lough, and it was decided by them that a scheme of sewage purication was necessary; the scheme eventually recommended by the City Surveyor being as already mentioned, that of treatment by bacteria beds. In the autumn of 1900, some months after this decision had been arrived at, Dr. Lorrain Smith and myself were commissioned by the city council of Belfast to make an experimental investigation on this scheme, and also to report on its probable effects on the Lough if it were carried out. I may here remark parenthetically that I sincerely trust Dr. Lorrain Smith will continue his bacteriological examinations. The results of my own work are embodied in a report which was handed in to the town clerk last August, copies of which are at your disposal, if you would like to have them. The first pages deal with general matters concerning sewage disposal, and also contain an account of the investigation of the ulva, and of the nature and speed of the chemical changes which occur in mixtures of sewage and sea water, while the description of the special investigation on the scheme of sewage purification proposed for Belfast commences on page 24. With your permission I will now give a summary of the latter. The analytical work consisted of determinations of solids, free and albuminoid ammonia, and also of the total unoxidised nitrogen by Kjeldahl's process, nitrates, nitrites and chlorine, and of the "oxygen absorbed" by the permanganate test under different conditions, and, lastly, of the dissolved gases, all the analyses being made as far as possible simultaneously and with corresponding samples of the sewage as it flowed into the bacteria beds, and of the effluents from the first and second contacts. In all, twelve complete sets of such analyses were made under different conditions of weather, time, and season, in order to obtain information as to the average effect of the experimental bacteria beds as they were then installed. These beds were four in number, two upper and two lower, the dimensions of each bed being 90 feet long by 72 feet wide at the bottom, with an average depth of 3ft. 6in. The filling material used in three of the beds (one upper and two lower) was broken bricks, and in the remaining bed, coke—the material in all the beds being in fragments of much the same size, namely, about that of a hen's egg. As regards the samples, the sewage as it arrives at pumping station No. 1, in the high and low level sewers respectively is there mixed, and flows in a single culvert to pumping station No. 2, where it is collected in large covered tanks, and thence, after passing through a gauging well, a portion passed into the experimental bacteria beds.

It was thus thoroughly mixed before treatment, so that the collection of an average sample at a given time presented no particular difficulties.

All the samples, with the exception of those intended for the analyses of the dissolved gases, were taken by means of a "dipper," with which portions of the sewage or effluents were removed at stated intervals into a bucket, the contents of which were finally well mixed and transferred to stoppered Winchester quart bottles. The samples for the analyses of the dissolved gases were collected by a special arrangement in such a way that the sample did not come into contact with the air during the process. In the case of the sewage the samples for the analyses of the dissolved gases were collected from mid-depth of the liquid in the gauging well, and in the first six samples of the effluents examined the liquid was drawn from mid-depth of the bacteria beds; but, in the remaining six samples, the effluent after second contact was alone examined, but in each case two samples were analysed—one collected near the bottom of the bed, and the other from a depth of six inches below the surface.

I may mention in connection with the working of the experimental bacteria beds that during my experiments the duration of each cycle was about half the interval between two consecutive tides, or on an average $6\frac{1}{2}$ hours, the period of each operation being about as follows:—

Filling upper bed - - - - -	$\frac{3}{4}$ hour
Resting full - - - - - -	$2\frac{1}{2}$ hours
Emptying and filling lower bed -	$\frac{3}{4}$ hour
Resting full - - - - - -	$2\frac{1}{2}$ hours

The first nine series of analyses were made with samples collected from one pair of upper and lower beds which were filled with the brick fragments, but owing to repairs which had to be executed on these beds, the remaining three series were made with samples collected from the other pair of beds, the upper of which contained the coke filling. There are some very remarkable and interesting differences in the analytical results obtained with the latter, which I shall draw attention to presently.

Coming now to the purification effected by the bacteria beds, the tables of results show that as the average of all the determinations $27\frac{1}{2}$ per cent. of the free or saline ammonia was lost from the screened and settled sewage after single contact with the beds (or rather after contact with the upper bed), and $51\frac{1}{2}$ per cent. after double contact. The corresponding figures for the albuminoid ammonia are 41·6 and 70·7 respectively, the decreasing amounts of these two factors being probably the surest index of the extent of purification.

The superiority of the beds filled with brick fragments over those the upper of which contained coke is brought out by the tables, and although, as it happened, the sewage was more concentrated when the effect of the latter beds was being investigated, the weather drier and warmer, and the number of samples analysed too few perhaps to draw any absolute conclusions, still I am of the opinion that the brick beds of the experimental installation were superior in their purifying effects to the other pair.

The figures for the total nitrogen (by Kjeldahl's process) show an average loss on all the samples of 36 per cent. after first contact, and 57 per cent. after the second. As, of course, was to be expected regarding this factor also, the brick beds appear as the more efficient purifying agencies.

As regards the oxygen absorbed test, which is often relied on for indicating the degree of prification effected, the figures given in the table (3) for the four hours' test show a purification of 47 per cent. for single contact, and 71 per cent. for double contact, the figures not differing very much from those of the albuminoid ammonia.

The average loss of free and albuminoid ammonia from the screened and settled sewage after double contact with the bacteria beds is represented graphically in Table 4 of the report, together with the purification indicated by the four-hour oxygen absorbed test, where they are also contrasted with the results obtained at Manchester (report of the Rivers Department, January 22nd, 1900, table 7) and Leeds (report on Sewage Disposal, December, 1898, table 1), at both of which cities very thorough investigations have been made by experts on the bacterial methods of purification

As the actual proportions of free and albuminoid ammonia both in the original sewage and also in the

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effluents after treatment vary considerably in the three cities, the usual plan has been adopted of expressing the purification as percentages of the original amounts, and the same thing has been done as regards the oxygen absorbed test.

The figures are in round numbers as follows:—

First Contact.	Percentage loss of		
	Free Ammonia.	Albuminoid Ammonia.	Oxygen Absorbed.
Belfast - - -	27	42	47
Leeds - - -	27	50	50
Manchester - -	45	55	72
Second Contact.			
Belfast - - -	51	71	71
Leeds - - -	51	74	82
Manchester - -	84	82	91

Setting aside the differences in the character of the sewage submitted to treatment, also those in the material with which the beds were filled, and in the cycle of working the chart shows:—

(1) That the purification as regards free ammonia is almost identical at Leeds and Belfast, and only slightly different as regards albuminoid ammonia. The purification as indicated by the oxygen absorbed test is higher at Leeds than at Belfast, but no particular importance need be attached to this, as the test in my opinion at least is misleading.

(2) The Manchester experiments show a much higher purification in all the above factors, and especially in the free ammonia, which, owing to the peculiar circumstances attending the discharge of sewage into Belfast Lough, is of great importance.

It seems probable that the preliminary treatment in the open septic tank to which the Manchester sewage was subjected previous to its treatment on the bacteria beds may account for this, and if so, a valuable hint is given as to the treatment of the Belfast sewage.

THE CHEMICAL AND BIOLOGICAL CHANGES OCCURRING IN THE BACTERIA BEDS.

It has, I believe, been generally assumed that bacteria beds act as oxidising agents, absorbing oxygen from the air during their periods of rest, and subsequently transferring it to the constituents of the sewage when the beds are filled with this latter, the transfer being effected by the micro-organisms which have established themselves on the surfaces of the material with which the beds are filled.

This view is certainly supported by the results of the "oxygen absorbed test," which invariably show that much less oxygen is absorbed from the permanganate by the sewage after treatment than before.

It has also, I think, been further assumed that the micro-organisms mainly concerned in the purification process are the so-called "nitrefying organisms," whose function it is eventually to oxidise the nitrogen of the nitrogenous constituents to nitric acid, or rather to nitrates, the necessary bases for the production of these salts being present in the sewage, and their presence being, indeed, essential for the nitrefying process.

Nitrites may also be formed either by the reduction of the nitrates or by incomplete oxidation.

Hence, if these views are correct, the effluent from the bacteria beds should contain nitrates and nitrites equivalent in amount to the unoxidised nitrogen which has disappeared during the treatment.

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DISSOLVED GASES.

TABLE showing the Amount of Dissolved Gases in the Screened and Settled Sewage before and after contact with the Dibdin Filter Beds.

Date	Series	CUBIC CENTIMETRES PER LITRE.																	
		CARBONIC ANHYDRIDE.					NITROGEN.					OXYGEN.			MARSH GAS.			HYDROGEN.		
		Actual Quantities.			Gain or Loss.		Actual Quantities.			Gain or Loss.		Actual Quantities.			Actual Quantities.			Actual Quantities.		
		Original Sewage.	After First Contact.	After Second Contact.	After First Contact.	After Second Contact.	Original Sewage.	After First Contact.	After Second Contact	After First Contact	After Second Contact.	Original Sewage.	After First Contact.	After Second Contact.	Original Sewage	After First Contact.	After Second Contact.	Original Sewage.	After First Contact.	After Second Contact.
6 January - - -	1	122·97	130·60	126·72	7·63	3·79	17·61	18·25	19·76	0·64	2·15	0	0	0·19	–	–	–	–	–	–
20 „ - - -	2	89·56	94·76	88·71	5·20	–0·85	17·81	19·06	18·59	1·25	0·78	0	0	0	–	–	–	–	–	–
29 „ - - -	3	102·37	104·23	99·64	1·86	–2·73	18·51	19·39	19·85	0·88	1·34	0	0	0	0	0	0	0·38	0·39	0·40
5 February - - -	4	102·12	109·36	105·59	7·24	3·47	18·51	19·74	19·92	1·23	1·41	0·05	0	0	0·38	0	0	0	0	0·20
12 „ - - -	5	110·91	125·41	118·55	14·50	7·64	17·72	19·82	20·86	2·10	3·14	0	0	0	0·36	0	0	0	0	0
19 „ - - -	6	108·83	128·72	129·14	19·89	20·31	17·50	18·59	21·00	1·09	3·50	0	0	0	0·54	0	0	9	0·38	0
3 March - - -	7	87·10	–	91·56	–	4·16	16·70	–	18·65	–	1·95	1·99	0	0	0	–	0	0	–	0
10 „ - - -	8	107·37	–	124·16	–	16·79	17·21	–	19·84	–	2·63	0	0	0	0·18	–	0	0·72	–	0
22 „ - - -	9	98·27	–	124·13	–	26·16	16·67	–	20·79	–	4·12	0	0	0	0·69	–	0	0	–	0
17 May - - - -	10	104·95	–	112·77	–	7.82	14·58	–	13·92	–	–0·66	0	0	0	1·03	–	0·65	1·54	–	1·61
31 „ - - - -	11	95·64	–	126·15	–	30·51	14·60	–	15·03	–	0·43	0	0	0	0·48	–	0·16	0·96	–	0
June - - - -	12	115·30	–	158·22	–	42·92	15·30	–	15·36	–	0·06	0	0	0	0·86	–	0·16	1·08	–	0·16

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But on examining the results obtained by chemists elsewhere, I have been much struck by the comparatively small amounts of nitrate and nitrite they have found in relation to the unoxidised nitrogen disappearing.

The following figures have been calculated partly from the results given in the Manchester and Leeds reports, already referred to, and partly from the table (p. 68) given in Dibdin's book on "The Purification of Sewage and Water."

—	Nitrogen disappearing as "free" and "albuminoid" ammonia.	Nitrogen found in the effluent as nitrate and nitrite after double contact with the bacteria beds.	
	(Grains per gallon.) Actual amount.	(Grains per gallon.) Actual amount.	Percentage on nitrogen disappearing.
Manchester - - - - - -	1·634	0·636	39
Sutton - - - - - - -	7·185	1·100	15
Leeds - - - - - - -	1·528	0·11	7

While at Belfast the discrepancy is still more marked, as practically no nitrate or nitrite appeared in the effluent.

It is quite evident, therefore, that a considerable portion, and in most cases the greater part, of the unoxidised nitrogen which disappears must be got rid of in some other form, and the question arises as to how this may occur.

It seems to me that there are two, and only two, alternative ways in which it can be lost. (1) It may escape in the gaseous state, or possibly as gaseous oxides of nitrogen; and (2) it may pass into the tissues of animals or vegetables which either escape from the bacteria beds or remain in them.

In other words, there may be either a chemical or a biological explanation, or both together, and I shall examine each of these separately.

Chemical Explanation.—For reasons already mentioned, chemists have scarcely paid any attention to the gases held in solution by sewage or the effluents from the bacteria beds. In the present investigation, however, considerable time and labour were devoted to this matter, and the results obtained are, I venture to hope, suggestive and interesting.

If the table showing the composition of the dissolved gases is examined, it will be seen that (1) practically no oxygen was present either in the sewage or the effluents; (2) that the effluent from the first contact always contained considerably more carbonic anhydride than the original sewage, and that, with two exceptions, the effluent from the second contact also contained an excess of that gas; (3) that in the first nine series of analyses the quantity of nitrogen in the effluents was invariably in excess of that present in the original sewage, and that, generally speaking, it was in larger excess in the effluent from double contact than in that from single contact.

There can, therefore, be no doubt whatever that some of the nitrogen present in the combined state in the sewage is converted into free nitrogen, and it was easy to calculate what proportion of the unoxidised nitrogen disappearing from the sewage made its appearance as dissolved nitrogen in the effluent. As the first six series of analyses only were made under exactly the same conditions, I have taken them alone into consideration for that purpose, and I find that on the average the excess of nitrogen in the effluent from second contact (over that present in the sewage) amounted in weight to 0·272 parts per 100,000, while the loss of unoxidised nitrogen which had occurred in the sewage (by Kjeldahl's process) amounted to 2·2 parts, or that 12 per cent. of the nitrogen lost from the sewage during purification was thus accounted for, while in one particular case it amounted to nearly 20 per cent.

But it must be mentioned that in all probability only a fraction of the gaseous nitrogen actually evolved would be retained by the effluent, as the latter can only dissolve a certain amount of the former, and consequently a good deal of nitrogen may have escaped into the air.

A singular feature of the analyses is that when a change was made in the beds, and the samples were taken from that pair, the upper of which contained coke, no evolution whatever of free nitrogen was observed in the first series of samples examined (series 10), while the two later series (11 and 12) showed only very slight evolution.

This is very curious, and at present I can offer no explanation of it, but I may recall the fact already mentioned, that these beds showed themselves to be much inferior as purifying agents to the other pair.

There are some other points connected with the dissolved gases which are of interest, but which I must content myself by merely mentioning. For instance, the entire absence of dissolved oxygen from the effluents shows that the changes occurring in the bacteria beds must, to some extent at all events, be of an anærobic nature, and not entirely ærobic, as I think is generally assumed; also, the very considerable quantities of carbonic anhydride evolved during the first contact, and the decrease which (as a rule, but not invariably) occurs during second contact are interesting. Finally, it may be asked, By what mechanism is the free nitrogen produced from the nitrogenous compounds? It is probably microbic, and, indeed, certain definite species of organisms are known which possess the power of liberating nitrogen from nitrogenous substances, but the whole subject requires further investigation.

Biological Explanation.—As regards the possibility that nitrogen is lost biologically, *i.e.*, is absorbed into the tissues of animals or plants which feed on the sewage, I am quite certain that a portion does escape in this way. The bacteria beds both in Belfast and at other places I have visited, swarm with minute insects, which are black in colour and wingless, and which I believe are of the species "Podura Aquatica." Escaping in myriads from the beds, they often form quite a thick layer on the surface of the pond into which the effluent flows before it passes into the Lough—a layer which looks like soot. There can be no doubt that in thus escaping these animals carry with them some of the nitrogenous constituents of the sewage which they have devoured, but as yet I have formed no estimate of the quantity thus removed.

There is also a kind of worm always present in the effluent in fair quantities, which no doubt feeds on the sewage. What subsequently becomes of it I do not know.

In addition to these two species of higher animal organisms there are, of course, vast numbers of animalculæ, but as the nitrogen contained in their bodies is estimated along with that of the nitrogenous constituents of the sewage, and as they no doubt remain in the effluent, they cannot be exactly said to function as "Nitrogen Removers."

That nitrogen actually escapes from the bacteria beds, partly as gas and partly in the bodies of animal organisms, is of the highest importance in virtue of the peculiar circumstances connected with the discharge of sewage into the Lough.

If the nitrogen of the nitrogenous constituents of the sewage were simply converted by the action of the beds into ammonia and nitrates, then there would not be much prospect of getting rid of the "ulva latissima" from the Lough, for, as previously shown in this Report,

these are the very substances which encourage its growth.

But this is certainly not the case, the bacteria beds functioning more as *dispersers* of nitrogen than as mere *converters* of it into simpler compounds to be absorbed into the tissues of the seaweed, and eventually, when the latter rots on the foreshore, to reproduce the effects of foul sewage.

I will now, with your permission, read the conclusion of my report, for I find I cannot easily give you a summary, as most of itself is a summary.

CONCLUSIONS.

(1) The treatment of the sewage by double contact with bacteria beds and the discharge of the resulting effluent into the Lough, is, under all the circumstances, the most suitable method for the disposal of the sewage of Belfast.

[As regards the expression "under all the circumstances," at the time of making my report I was under the impression that the Corporation of Belfast were bound absolutely by their Act to carry out some system of sewage purification within three years from the date of the passing of the Act, and if that were the case, treatment by bacteria beds seemed to be the safest and best course to adopt. As, however, an extension of the time is now unavoidable and further experiments are to be made, it is quite possible that a better method of disposal will suggest itself than that of treatment on bacteria beds only.]

(2). The nuisance in Belfast Lough, or the "foreshore nuisance," is caused entirely by decomposition of the green seaweed ulva latissima, the growth of which in such enormous quantities is mainly due to the discharge of the crude sewage of the city into the Lough.

(3) It is probable that with efficient purification of the sewage escaping into the Lough the seaweed will eventually be so reduced in quantity as to cease to give rise to a nuisance.

I subsequently made some

RECOMMENDATIONS,

which were as follow:—

(1) The best material for filling the bacteria beds should be investigated, as it is evident that in the present experimental installation the coke beds are inferior in their purifying action to the brick beds. Beds of clinker have been largely used elsewhere with satisfactory results, and the new "destructor" should supply an abundance of suitable material.

Also I think it possible that finer grained material might be employed in the lower beds with advantage. In view of the results obtained at Manchester, it seems worth while to try the effects of septic tank treatment on the sewage previous to that of the bacteria beds. Experiments could, I belive, be tried in this direction with the present tanks.

(2) As regards the foreshore nuisance there are several points I would direct attention to.

(*a*) Although the growth of the ulva latissima in such vast quantities is mainly due to Belfast sewage, it is undoubtedly assisted by the discharge of sewage from the towns and villages situated along the shores of the Lough. These ought also to adopt a system of purification if the nuisance is to cease. The discharge of large quantities of distillery refuse into the Connswater river also, very possibly materially encourages the growth of the seaweed. If possible this should be discontinued.

[Mr. Bretland is under a slight mistake as regards the disposal of sewage at Cultra, the little place on the coast where I live. The landlord of Cultra is an exceedingly enlightened man, who is anxious to introduce anything he can for the benefit of his tenants, and to improve the sanitation of the place. He has had installed a complete system of drainage and sewage treatment for his tenants. The sewage passes into a septic tank, and thence on to bacteria beds, which are certainly far too small, owing to a mistake of the engineers, but they still partially purify the sewage, and it is only after this treatment that the sewage passes into the Lough.] I should like to be absolutely clear that the distillery refuse from the Irish Distillery, a very large one, does not run into the river, the Connswater river, not the Lagan river.

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13517. (*Chairman.*) You spoke of the distillery refuse as probably promoting the growth of the ulva, can you tell us what is the chemical composition of the effluent? Have you made any analysis?—Well, I should really not like to commit myself to figures. It is a long time ago since I made any analysis. It is very highly nitrogenous. If it ran in it would, in my opinion, carry with it a great deal of free ammonia.

13518. Have you any idea of its volume?—Well, it is very large.

13518*. So that it is an appreciable factor?—Yes, there can be no question about that.

The witness then continued to read the recommendations as follows:—

(*b*) If there were no slob lands or sand banks for the ulva to grow and collect on, there would be no nuisance. Hence reclamation of these large tracts of foreshore should be encouraged.

(*c*) A great deal might be done by the proper sanitary authorities to keep the foreshore clean. The indifference displayed in this matter is extraordinary, and the condition of the foreshore I can only describe as being often scandalous. A few men and carts constantly employed at different points in clearing away the seaweed could do much to prevent this annually occurring and really serious nuisance. As it is, however, deposits of the seaweed of considerable depth are allowed to remain for months until they are stinking masses of corruption, and are only dissipated eventually by a gale from the proper quarter of the compass.

It is, however, only fair to say that at Holywood attention is paid to this matter, where men and carts are constantly employed in removing the seaweed as fast as it is washed ashore.

(*d*) I am convinced that the foreshore nuisance is injurious to health—not perhaps by inducing any dangerous disease, but in causing nausea (and even vomiting), headache, loss of appetite and depression, and also, I am inclined to believe, sore throat. It certainly affects the comfort of the people as well as the value of their property.

(3) Even under the best system of purification, the resulting effluent will still contain sufficient ammonia to encourage the growth of the ulva to some extent, but in my opinion it would be quite possible to utilise the seaweed itself as a further purifying agent. This could be done by allowng the effluent to flow into ponds containing sea water and the growing ulva, and after a suitable period of contact discharging the mixture of sea water and effluent into the Lough in such a manner as to retain the seaweed within the ponds. As my laboratory experiments show that a period of four or five hours is sufficient to remove practically all the ammonia, the ponds might be made tidal, and the effluent discharged into them during the rising tide. The liquid escaping during the falling tide would (if matters were managed properly) be free from ammonia and nitrate, and would no longer be fit to encourage the growth of the seaweed in the Lough itself. As the former, when fresh, is easily disposed of either by drying and burning or by digging into the ground (and as already stated it is an excellent manure), its amount in the ponds could be kept under control without difficulty.

Dr. Letts afterwards said: "In my report, as I have just explained, certain recommendations were made involving a further experimental investigation, and similar recommendations were made by my colleague, Dr. Lorrain Smith. Some delay has, however, occurred in our receiving a mandate from the city authorities to commence this work, but I have been recently informed by the town clerk that the committee in charge have passed a resolution authorising us to proceed with it, which is to be brought before the Council in a few days. Under these circumstances, I think I am justified in indicating the lines of research we are anxious to pursue.

"(1) We wish to make some further experiments as regards the most suitable materials for the filtering beds, and the size of the fragments to be employed. We propose to compare the effects on the same sewage of samples of broken bricks, coke, clinkers, and stones. Of course, a good deal of work has been done on this subject, but as the results are in some cases rather contradictory, we think it advisable to work out the matter as far as possible in relation to the Belfast sewage. You have seen that the plant for these experiments is,

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to a considerable extent on a working scale, so that while our experiments are progressing an increasing quantity of sewage will be purified.

"(2) In view of the Manchester results, we think it very desirable to try the effect of septic tank treatment previous to filtration, and for that purpose, as you have seen, a small septic tank and a set of small experimental beds have been constructed.

"(3) Then I am desirous of studying the effects of oxidising filters on the Belfast sewage. I mean of filters giving an effluent with a high proportion of nitrates, because I wish to ascertain whether, on mixing a fully oxidised effluent with an ordinary effluent such as we have, or with screened and settled sewage, the nitrates from the first will react with the unoxidised nitrogenous constituents of the second leading to loss of gaseous nitrogen. These experiments will, of course, be supplemented by laboratory experiments on the effects of adding nitrates to sewage, and analyses of the dissolved gases before and after this treatment.

"(4) Dr. Smith and myself are most anxious to get, if possible, a clearer idea of the chemical and biological changes occurring in the bacteria beds, than anyone seems to have at present, and also in the septic tank. We all know how rapid the changes are, but as yet no completely satisfactory explanation of them seems to have been put forward. The cause of the loss of so high a proportion of nitrogen as occurs in the bacteria beds remains a mystery.

"(5) Then, as regards the ulva, much work remains to be done, and I confess that personally I feel a heavy responsibility as regards this matter, because, while it has been comparatively easy to explain the causes of our foreshore nuisance, the remedy is by no means so simple a matter. If we could reclaim the slob lands and banks I feel sure that the nuisance would cease, but I am told that the expense involved would be enormous and out of the question. All I can suggest at present is to starve the weed out, cut off, as far as possible, its supplies of nitrogenous food. This can undoubtedly be done to some extent, and I am sure to a considerable extent by these so-called bacterial methods of purification. Can we get rid of the rest, or practically do so by utilising the seaweed itself? Can we work an aquatic or marine sewage farm in such a way that the effluent from the purification works shall pass into an enclosed area, where it will meet with a crop of the ulva under control, and under the most favourable conditions, and pass out free from those matters which will encourage the growth of the seaweed which is beyond control? These are practical problems which will not be solved easily or in a short time, but I think they are clearly among the most important we have to attack."

13519. (*Chairman.*) We have listened with very great interest to the evidence you have put before us Dr. Letts. We gather you think a remedy for this lies in four directions, of which one is not practicable because of its exceeding expense, namely, the confining in of these lands so as to reclaim them. You think that is impracticable?—Yes.

13519*. But the others are practicable you think, one by a process of sewage treatment which will largely reduce the amount of free ammonia in the effluent. Another by a treatment—and this is a very interesting suggestion—on what you call an aquatic sewage farm, by the utilisation of this growth of the ulva, which left to itself naturally brings about the nuisance. The third suggestion also is well worthy of consideration, the suggestion of the removal of the ulva and its utilisation upon the land. Do you think that the growth of the ulva causes the only nuisance so far as you have found?—Yes.

13520. Seeing that the only nuisance caused is minimised by carting away the portions of the ulva left upon the banks, and amassed there under conditions in which it cannot live, and decays, do you not think that the authorities might to some extent meet the difficulty by joining together in the expense of its removal from the shores?—Yes, I think so.

13521. What is the length of the shore on either side?—On the southern side the nuisance extends a very much greater distance along the coast than on the northern, why I cannot understand; perhaps because of the prevalence of westerly winds.

13522. What is the total length of the coast affected? What do you think?—I should say seven or eight miles.

13523. We saw that a considerable quantity of the ulva was being removed yesterday. What would be the cost of the removal of the decaying ulva? I could hardly say.

13524. Would it be a very serious expense?—Well, it is a financial question which I am afraid I am not competent to answer.

13525. Do you think it would be worth inquiry into the matter of expense?—Yes, I certainly do; there has been the greatest neglect of the foreshore.

13526. The growth of the ulva brings about the purification of the seawater, and it is only when it gets on the banks and rots that it becomes a nuisance?—Yes, that is so. I have sometimes compared the ulva with a vulture. When it is alive it acts as a scavenger, but it is decaying matter when it dies, and it thus becomes a nuisance.

13527. The ulva seems to be limited to a narrow strip of the shore?—Yes.

13528. Then it would not be a very serious matter to have it removed?—I cannot say as to the expense.

13529. But supposing this mass of ulva were removed the nuisance would cease?—Without the slightest doubt.

13530. Then it would be worth while for the authorities to inquire into the possible cost of removal by carts?—It would without the slightest doubt.

13531. Your suggestion of aquatic sewage farms is very interesting. Have you formed any opinion as to the size of the beds?—That is one of the points that require investigation on a practical scale, for since my experiments on the assimilation of nitrogenous compounds by the ulva, it has often occurred to me that the treatment of the merely clarified sewage mixed with sea water, by the ulva would be a rational and simple method of treatment—apart altogether from the so-called bacterial methods of purification. It might, of course, be found advisable to combine the two.

13532. But the experiment would not be a very expensive one, would it?—No, I do not think so. It would be quite possible. The only difficulty I can see, apart from laboratory experiments, is the proof that the resulting effluent would fail to support the growth of the ulva in the Lough.

13533. To encourage the growth of the weed treatment so that at another stage these gases might be removed?—Yes, my only difficulty would be a practical proof that the effluent from the marine sewage farm would no longer supply nourishment to the ulva outside.

13534. Then the only thing is to treat the sewage by a known process, so as to reduce as far as possible the elements which conduce to the growth of the weed until further investigations have resulted in your advising some other method?—That would seem to be the best course to adopt. When I do bring my investigation to a close I should be glad to place the results before the Commission.

13535. I gather from your evidence that you think this is a case where the Corporation of Belfast would be very wise in carrying out a series of experiments before they launch themselves finally into a scheme?—Yes. I have always pointed that out. It is an important matter.

13536. Have you any analysis of the crude sewage of Belfast apart from sedimentation?—No, sir. I had so much work to do in connection with other branches of the investigation that I had no time.

13537. In the analyses put before us by the city surveyor, the analyses of Mr. Barklie, those were analyses of screened and partly settled sewage, and it is evident that the analyses should be of screened, but not settled sewage?—I was only anxious to ascertain what went on to the beds.

13538. What is the average of the amount of suspended solids?—I have not averaged it up.

13539. It is evident that the whole of the suspended matters must be taken into consideration. If the sludge were let off into the sea it would serve as food for the ulva?—Without doubt, I think.

13540. Then the crude sewage must be taken into account, and not settled sewage?—Certainly, but in Belfast the conditions are such that we can easily dispose of the sludge, and therefore I have not paid any special attention to that branch of the subject.

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13541. But in any case it ought not to be let out into the waterway?—Certainly not.

13542. I find here in the analyses made the suspended matters may be said to average about 30 grains per gallon. I don't think that would be the average of my figures, sir.

13543. (*Chairman.*) (*To Mr. Bretland.*) Has your Corporation considered at all that suggestion to meet the difficulty of removal by carts of decaying matter along the shores?—(*Mr. Bretland.*) The Corporation have to some extent grappled with that difficulty of some removal of the weed by the local authorities.

13544. What would be the expense, do you think?—It would be substantial, but not very much.

13545. Do you think it would be worth while to consider that?—Yes. I do, sir, well worth while.

13546. If these matters were regularly removed the ulva growth might be looked upon as an inoffensive growth?—Yes, but it would require co-operation.

13547. Suppose the cost of it were a couple of thousands a year that would not be prohibitive?—I question whether it would be or not. The cost of the outlay on a scheme like this would probably be much more.

(*Dr. Letts.*) (*To the Chairman.*) The average of suspended solids is 16 per hundred thousand in the screened and settled sewage.

13548. (*Chairman.*) If settled sewage was first passed over the beds and the effluent turned from it into the seaway, the sludge deposit must not be allowed to go into the seaway?—

(*Mr. Bretland.*) I hope, sir, you don't think it should be turned out into the sea?—No, I don't think so, but nothing was said of any process by which the sludge should be dealt with.

(*Mr. Bretland.*) I remarked on it in evidence given before the Local Government Board.

13549. (*Dr. Russell.*) (*To Dr. Letts.*) The complaints about the nuisance from the ulva are confined to the summer months?—Yes, almost entirely to the summer and autumn.

13550. What is the exact period?—It begins, I think, from May to June, and I have known it to continue to December.

13551. But the sewage goes on all the year round. Does the weed flourish, or, rather, is it cast up by the tide, and does it decay all the year round?—No, sir, I think it is an annual.

13552. So that it is not being produced in the winter?—No, sir, I don't think so.

13553. That makes the prospective cost of this system of removal less?—Yes, there will be no necessity for any carting between January and July.

13554. That is nearly six months?—Yes.

13555. Do you know anything about the effect of this ulva upon bacterial life, say, in the estuary?—No. I have not investigated that at all. Certainly in an aquarium it keeps the aquarium from becoming foul.

13556. It would be interesting to know whether it absorbs the pabulum?—Yes, that would be interesting.

13557. (*Chairman.*) It is only during certain portions of the year that carting would have to be done?—Yes.

13558. And in that case we might look upon the growth of the ulva in the estuary as a natural growth which would not involve any cost to the local authorities?—Yes.

13559. Is there no bathing along that coast?—Very little; they have quite given it up at Cultra.

13560. (*Mr. Stafford.*) On which side of the Lough is the larger deposit?—On the south side.

13561. How do you account for that?—I can't account for it unless it is the prevalence of westerly winds or north-westerly winds.

13562. Is there more sewage on the south side of the Lough?—No, I think not. Formerly there was more ulva on the northern side than at present.

13563. Have you any theory for the disappearance partially on the northern side?—No.

13564. It is interesting to know why it has disappeared practically on one side?—Might I suggest as an explanation of the increase on the southern shore that formerly the large distillery—the Irish Distillery Co.—did not send their refuse directly into the sea down the Connswater river. Then for some time they certainly did so, which might account for the increase.

13565. Where does the Connswater river discharge?—It discharges close to Sydenham Station.

13566. But that would not explain the decrease on the northern side?—No; whether it is owing to any change in the current or in the nature of the bottom I cannot tell.

13567. There must be an explanation. In reference to conclusion three in your report, have you any idea of the standard of efficient purification which will prevent the growth of the seaweed in the Lough?—No, I have not. Provisionally, I think we should aim at a reduction of 90 per cent. in the free ammonia.

13568. That would be desirable?—Yes.

13569. Does it seem to you that the practical effect of that would be to reduce the population of Belfast to a ninth as regards its sewage effect upon the Lough?—Yes, or rather to a tenth.

13570. Therefore practically you would only have 37,000 people?—Yes.

13571. Have you made any experiments as to the 90 per cent.?—No. What I had in my mind was the reduction obtained at Manchester.

13572. You cannot at present advise the Corporation as to what degree of purification they should insist upon obtaining?—No, I don't see that yet.

13573. But after further experiments you would be obliged to give advice on that subject?—Yes, I hope so.

13574. You recognise that it is very important to give a degree of purification?—Of course.

13575. What degree of purification do you get from the present system?—I think it is 51 or 52, as regards free ammonia.

13576. What is the albuminoid ammonia?—I think it is 70 per cent.

13577. You have not decided upon how much further purification you should obtain?—I think we should obtain what Manchester obtains.

13578. I see it is 85 per cent. reduction?—If Manchester does it I don't see why we should not obtain that also.

13579. (*Chairman.*) I see at Leeds 81 per cent. reduction on the crude sewage was obtained, and with a septic tank over 90 per cent. That is essential for Belfast?—Yes, that is the sort of purification I should aim at getting.

13580. You require as much purification as they get in the inland towns?—Yes, I think so, to prevent the growth of the ulva we must get the highest possible degree of purity.

13581. (*Dr. Russell.*) Was there any complaint from the north shore of deposit?—Yes.

13582. And is it bad still?—Yes, as far as Greencastle.

(*Chairman.*) Thank you, Dr. Letts.

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APPENDIX TO Dr. E. A. LETTS' EVIDENCE.

TABLE I.

ANALYSES OF SEWAGE AND EFFLUENTS.

Series.	Date.	Nature of the Sample.	Rainfall at 9 a.m. on day of collection for past 24 hours.	Parts per 100,000. Solids. Suspended. Fixed.	Suspended. Volatile.	Suspended. Total.	Dissolved. Fixed.	Dissolved. Volatile.	Dissolved. Total.	TOTAL.
			Inches.							
1	6 January (Sunday.)	Sewage		3·4	10·7	14·1	81·4	22·0	103·4	117·5
		First effluent	0	–	–	–	–	–	–	–
		Second effluent*		?	?	?	137·0	25·0	162·0	162·?
2	20 January (Sunday.)	Sewage		4·0	4·4	8·4	73·7	17·1	90·8	99·2
		First effluent	0·06	–	–	–	–	–	–	–
		Second effluent*		?	?	2·3	90·4	15·6	106·0	108·3
3	29 January (Tuesday.)	Sewage		2·7	8·6	11·3	89·8	17·2	107·0	118·3
		First effluent	0·08	–	–	–	–	–	–	–
		Second effluent*		1·3	1·1	2·4	87·7	13·4	101·1	103·5
4	5 February (Tuesday.)	Sewage		3·1	12·2	15·3	85·7	22·2	107·9	123·2
		First effluent	0·005	–	–	–	–	–	–	–
		Second effluent*		1·2	2·6	3·8	87·7	13·6	101·3	105·1
5	12 February (Tuesday).	Sewage		2·7	9·0	11·7	135·6	28·9	164·5	176·2
		First effluent	0·010	–	–	–	–	–	–	–
		Second effluent*		?	?	2·4	122·2	21·6	143·8	146·2
6	19 February (Tuesday.)	Sewage		1·7	12·7	14·4	161·4	37·3	198·7	213·1
		First effluent	0·016	–	–	–	–	–	–	–
		Second effluent*		1·2	2·9	4·1	150·9	24·3	175·2	179·3
7	3 March (Sunday.)	Sewage		10·5	8·0	18·5	65·3	14·2	79·5	98·0
		First effluent	0·43	–	–	–	–	–	–	–
		Second effluent†		?	?	1·7	97·3	12·5	109·8	111·5
8	10 March (Sunday.)	Sewage		?	?	6·7	92·4	19·7	112·1	118·8
		First effluent	0	–	–	–	–	–	–	–
		Second effluent†		0·4	2·7	3·1	100·5	13·5	114·0	117·1
9	22 March (Friday.)	Sewage		1·1	15·2	16·3	129·4	41·3	170·7	187·0
		First effluent	0	–	–	–	–	–	–	–
		Second effluent†		2·2	4·5	6·7	130·8	20·5	151·3	158·0
10	17 May (Friday.)	Sewage		0·9	31·1	32·0	293·4	72·6	366·0	398·0
		First effluent	0	–	–	–	–	–	–	–
		Second effluent†		?	?	1·7	229·8	44·2	274·0	275·7
11	31 May (Friday.)	Sewage		3·9	18·2	22·1	223·9	48·1	272·0	294·1
		First effluent	0·31	–	–	–	–	–	–	–
		Second effluent†		1·8	6·7	8·5	192·4	33·6	226·0	234·5
12	7 June (Friday.)	Sewage		1·7	12·7	1·44	223·2	50·3	273·5	287·9
		First effluent	0	–	–	–	–	–	–	–
		Second effluent†		?	?	5·4	231·5	33·3	264·8	270·2

* Sample for dissolved gases collected from mid-depth of bacteria bed.

† ,, ,, ,, ,, ,, ,, 6 inches below the surface of the bacteria bed.

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TABLE I.

ANALYSES OF SEWAGE AND EFFLUENTS.

Cubic centimetres per litre at N.T.P.				Parts per 100,000.									
Dissolved Gases.				Nitrogen as						Oxygen absorbed test at 80° F.			
				Unoxidised.				Oxidised.		After			
Carbonic Anhydride.	Oxygen.	Residual gases.	Total.	Free Ammonia.	Albuminoid Ammonia.	Sum of Free and Albuminoid Ammonia.	Total (Kjeldahl).	Nitrites.	Nitrates.	Three minutes.	Four hours.	Five days' incubation (Three minutes).	Chlorine.
122·97	0	18·06	141·03	3·62	0·92	4·54	5·60	0	0	–	10·87	–	54·4
130·60	0	18·43	149·03	2·43	0·39	2·82	2·63	0	0	–	4·68	–	60·0
126·72	0·19	20·06	146·97	1·48	0·16	1·64	2·31	0	0	–	2·56	–	63·8
89·56	0	18 26	107·82	1·48	0·66	2·14	2·31	traces	0·04	1·88	6·89	3·68	23·7
94·76	0	19·26	114·02	0·82	0·33	1·15	0·99	0	0	0·83	2·24	0·90	35·0
88·70	0	18·87	107·57	0·39	traces	0·39	0·82	0	0·04	0·30	1·87	0·45	38·0
102·37	0	18·89	121·26	1·84	0·58	2·42	2·96	0	0	1·82	6·00	5·34	36·2
104·23	0	19·77	124·00	1·15	0·53	1·68	2·04	0	0	1·12	3·02	0·72	35·2
99·64	0	20·24	119·88	0·74	traces	0·74	0·91	0	0·08	0·56	1·52	0·62	35·1
102·12	0·05	18·89	121·06	1·56	0·74	2·28	2·80	0	0	2·34	8·38	5·11	34·2
109·36	0	19·77	129·10	1·07	0·33	1·40	1·56	0	0	1·10	3·22	2·21	34·7
105·59	0	20·12	125·71	0·66	traces	0·66	0·66	0	0·04	0·78	2·15	0·85	34·9
110·91	0	18·08	128·99	2·47	0·74	3·21	3·62	0	0	2·44	8·44	6·52	64·8
125·41	0	19·82	145·23	1·90	0·41	2·31	2·55	0	0	1·29	3·67	1·80	57·5
118·55	0	20·85	139·40	1·32	0·36	1·68	1·73	0	0·10	0·86	2·35	1·07	56·5
108·83	0	18·04	126·87	2·30	0·91	3·21	4·12	0	0	3·11	9·73	8·98	80·0
128·72	0	18·97	147·69	1·58	0·56	2·14	2·80	0	0	1·66	4·85	3·62	75·5
129·14	0	21·00	150·14	1·32	0·39	1·71	1·81	0	0·02	0·91	3·07	1·42	72·2
87·10	1·99	16·70	105·79	1·15	0·41	1·56	2·14	0	0·18	1 61	4·65	2·45	23·1
–	–	–	–	0·82	0·20	1·02	1·23	0	0	0·73	1·55	0·99	32·6
91·56	0	18·65	110·21	0·46	0·20	0·66	0·91	0	0·08	0·48	1·28	0·40	40·0
107·37	0	18·11	125·48	1·65	0·50	2·15	2·31	traces	0·10	1 67	5·52	3·02	38·0
–	–	–	–	1·05	0·30	1·35	1·73	0	0·02	1·20	3·28	1·55	40·2
124·16	0	19·84	144·00	0·74	0·20	0·94	1·07	0	0·06	0·60	1·68	0·69	41·2
98·27	0	17·36	115·63	1·90	1·05	2·95	3·46	0	0·04	3·49	9·37	8·39	61·5
–	–	–	–	1·25	0·72	1·97	2·80	0	0	2·18	7·25	6 13	61·5
124·43	0	20·79	145·22	0·90	0·41	1·31	1·65	0	0	1·20	3·60	1·98	61·5
104·95	0	17·15	122·10	2·39	1·91	4·30	5·43	0	0	5·55	18·81	8·40	158·6
–	–	–	–	2·24	0·91	3·15	3·46	0	0	3·21	9·29	8·77	138·6
112·77	0	16·18	128·95	1·56	0·49	2·05	2·77	0	0	1·71	4·81	3·26	122·1
95·64	0	16·03	111·67	2·04	0·91	2·95	3·79	0	0·02	3·58	9·66	10·05	118·5
–	–	–	–	1·65	0·59	2·24	2·72	0	0	2·01	5·67	4·97	107·3
126·15	0	15·19	141·34	1·07	0·39	1·46	1·89	0	0	1·15	2·89	1·78	100·3
115·30	0	17·19	132·49	3·21	1·40	4·61	5·43	0	1·31	4·07	9·85	11·44	117·7
–	–	–	–	2·63	0·99	3·62	3·82	0	0·12	2·71	7·51	7·46	119·2
158·22	0	15·68	173·90	1·81	0·53	2·34	2·63	0	0·00	1·51	3·70	2·66	121·4

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TABLE II.

TABLE showing the amount of Nitrogen present as "Free Ammonia" and as "Albuminoid Ammonia" in the Screened and Settled Sewage before and after contact with the Dibdin Filter Beds, and the Purification effected.

Date.	Series.	PARTS OF NITROGEN PER 100,000 OF FLUID AS									PERCENTAGE PURIFICATION IN					
		FREE AMMONIA.			ALBUMINOID AMMONIA.			TOTAL (By Kjeldahl's Process).			FREE AMMONIA.		ALBUMINOID AMMONIA.		TOTAL (By Kjeldahl's Process).	
		Original Sewage.	After First Contact.	After Second Contact.	Original Sewage.	After First Contact.	After Second Contact.	Original Sewage.	After First Contact.	After Second Contact.	After First Contact.	After Second Contact.	After First Contact.	After Second Contact.	After First Contact.	After Second Contact.
6 January - -	1	3·62	2·44	1·48	0·92	0·39	0·16	5·60	2·63	2·31	33	59	58	83	53	59
20 ,, - - - -	2	1·48	0·82	0·39	0·66	0·33	traces	2·31	0·90	0·82	45	74	50	100?	57	65
29 ,, - - - -	3	1·84	1·15	0·74	0·58	0·53	traces	2·96	2·04	0·91	38	60	9	100?	31	69
5 February - -	4	1·56	1·07	0·66	0·72	0·33	traces	2·80	1·56	0·66	32	58	54	100?	44	77
12 ,, - - - -	5	2·47	1·90	1·32	0·74	0·41	0·36	3·62	2·55	1·73	28	47	45	51	30	52
19 ,, - - - -	6	2·30	1·58	1·32	0·91	0·56	0·39	4·12	2·80	1·81	31	43	39	57	32	56
3 March - - - -	7	1·15	0·82	0·46	0·41	0·20	0·20	2·14	1·23	0·91	29	60	51	51	43	58
10 ,, - - - -	8	1·65	1·05	0·74	0·50	0·30	0·20	2·31	1·73	1·07	36	55	42	60	25	54
22 ,, - - - -	9	1·90	1·25	0·90	1·05	0·72	0·41	3·46	2·80	1·65	34	53	31	61	19	52
17 May - - -	10	2·39	2·24	1·56	1·91	0·91	0·49	5·43	3·46	2·77	6	35	52	74	36	49
31 ,, - -	11	2·04	1·65	1·07	0·91	0·59	0·39	3·79	2·72	1·89	19	48	35	57	28	50
7 June - - -	12	3·21	2·63	1·81	1·40	0·99	0·53	5·43	3·82	9·63	18	44	29	62	30	52
Average of all the samples - -		2·13	1·55	1·04	0·89	0·52	0·26	3·66	2·36	1·59	27	51	41	71	36	57
,, the first 9 - - -		2·00	1·34	0·89	0·72	0·42	0·19	3·26	2·04	1·32	33	55	42	73	38	60
,, the last 3 - - -		2·55	2·17	1·48	1·41	0·83	0·47	4·88	3·33	2·43	15	42	43	67	32	50

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TABLE III.

"OXYGEN ABSORBED TEST."

TABLE showing the amount of Oxygen absorbed from an Acid Solution of Potassium Permanganate at 80° F. by the Screened and Settled Sewage before and after contact with the Dibdin Filter Beds.

Date.	Series.	OXYGEN ABSORBED BY 100,000 OF FLUID AFTER— Three Minutes.			Four Hours.			Incubated Samples Three Minutes.			PERCENTAGE PURIFICATION INDICATED. Three Minutes.		Four Hours.	
		Original Sewage.	After First Contact.	After Second Contact.	Original Sewage.	After First Contact.	After Second Contact.	Original Sewage.	After First Contact.	After Second Contact.	After First Contact.	After Second Contact.	After First Contact.	After Second Contact.
6 January - - -	1	—	—	—	10·87	4·68	2·56	—	—	—	—	—	57	77
20 ,, - - -	2	1·88	0·83	0·30	6·89	2·84	1·87	3·68	0·90	0·45	56	84	59	73
29 ,, - - -	3	1·82	1·12	0·56	6·00	3·02	1·52	5·34	0·72	0·62	39	69	50	75
5 February - - -	4	2·34	1·10	0·78	8·38	3·22	2·15	5·11	2·21	0·85	53	67	62	74
12 ,, - - -	5	2·44	1·29	0·86	8·44	3·67	2·35	6·52	1·80	1·07	47	65	57	72
19 ,, - - -	6	3·11	1·66	0·91	9·73	4·85	3·07	8·98	3·62	1·42	47	71	50	68
3 March - - -	7	1·61	0·73	0·48	4·65	1·55	1·28	2·45	0·99	0·40	55	70	67	73
10 ,, - - -	8	1·67	1·20	0·60	5·52	3·28	1·68	3·02	1·55	0·69	28	64	41	70
22 ,, - - -	9	3·49	2·18	1·20	9·37	7·25	3·60	8·39	6·13	1·98	38	66	23	62
17 May - - -	10	3·55	3·21	1·71	18·81	9·29	4·81	8·40	8·77	3·26	42	69	51	75
31 ,, - - -	11	3·58	2·01	1·15	9·66	5·67	2·89	10·05	4·97	1·78	44	68	41	70
[illegible] June - - -	12	4·07	2·71	1·51	9·85	7·51	3·70	11·44	7·46	2·66	33	63	24	63
Average of all the samples - -		2·87	1·64	0·92	9·01	4·74	2·62	6·67	3·55	1·38	43	68	47	71
,, the first 9 - - -		2·29	1·26	0·71	7·76	3·82	2·24	5·44	2·24	0·95	45	69	50	71
,, the last 3 - - -		4·40	2·64	1·46	12·77	7·49	3·80	9·96	7·07	2·57	40	67	41	70

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TABLE 4.

DISSOLVED GASES.

TABLE showing the amount of Dissolved Gases in the Screened and Settled Sewage before and after contact with the Dibdin Filter Beds :—

Date.	Series.	Carbonic Anhydride. Actual Quantities. Original Sewage.	Carbonic Anhydride. Actual Quantities. After First Contact.	Carbonic Anhydride. Actual Quantities. After Second Contact.	Carbonic Anhydride. Gain or Loss. After First Contact.	Carbonic Anhydride. Gain or Loss. After Second Contact.	Nitrogen. Actual Quantities. Original Sewage.	Nitrogen. Actual Quantities. After First Contact.	Nitrogen. Actual Quantities. After Second Contact.	Nitrogen. Gain or Loss. After First Contact.	Nitrogen. Gain or Loss. After Second Contact.	Oxygen. Actual Quantities. Original Sewage.	Oxygen. Actual Quantities. After First Contact.	Oxygen. Actual Quantities. After Second Contact.	Marsh Gas. Actual Quantities. Original Sewage.	Marsh Gas. Actual Quantities. After First Contact.	Marsh Gas. Actual Quantities. After Second Contact.	Hydrogen. Actual Quantities. Original Sewage.	Hydrogen. Actual Quantities. After First Contact.	Hydrogen. Actual Quantities. After Second Contact.
		CUBIC CENTIMETRES PER LITRE.																		
6 January - - - -	1	122·97	130·60	126·72	7·63	3·79	17·61	18·25	19·76	0·64	2·15	0	0	0·19	–		–	–	–	–
20 " - - - -	2	89·56	94·76	88·71	5·20	– 0·85	17·81	19·05	18·59	1·25	0·78	0	0	0	–	–	–	–	–	–
29 " - - - -	3	102·37	104·23	99·64	1·86	– 2·73	18·51	19·39	19·85	0·88	1·34	0	0	0	0	0	0	0·38	0·39	0·40
5 February - - -	4	102·12	109·36	105·59	7·24	3·47	18·51	19·74	19·92	1·23	1·41	0·05	0	0	0·38	0	0	0	0	0·20
12 " - - -	5	110·91	125·41	118·55	14·50	7·64	17·72	19·82	20·86	2·10	3·14	0	0	0	0·36	0	0	0	0	0
19 " - - - -	6	108·83	128·72	129·14	19·89	20·31	17·50	18·59	21·00	1·09	3·50	0	0	0	0·54	0	0	0	0·38	0
3 March - - - -	7	87·10	–	91·56	–	4·46	16·70	–	18·65	–	1·95	1·99	0	0	0	–	0	0	–	0
10 " - - - -	8	107·37	–	124·16	–	16·79	17·21	–	19·84	–	2·63	0	0	0	0·18	–	0	0·72	–	0
22 " - - -	9	98·27	–	124·43	–	26·16	16·67	–	20·79	–	4·12	0	0	0	0·69	–	0	0	–	0
17 May - - - -	10	104·95	–	112·77	–	7·82	14·58	–	13·92	–	– 0·66	0	0	0	1·03	–	0·65	1·54	–	1·61
21 " - - - - -	11	95·64	–	126·15	–	30·51	14·60	–	15·03	–	0·43	0	0	0	0·48	–	0·16	0·96	–	0
12 June - - - -	12	115·30	–	158·22	–	42·92	15·30	–	15·36	–	0·06	0	0	0	0·86	–	0·16	1·03	–	0·16

Dr. LORRAIN SMITH, called; and Examined.

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13583. (*Chairman.*) You are Dr. Lorrain Smith, Professor of Pathology at the Queen's College, Belfast?—Yes.

13584. I think you have given a good deal of attention to the discharge of Belfast sewage into the Lough?—Yes; I have written a report of the investigations I have done so far.

13585. Do you propose to put that report in?—If you will allow me to do so. Meanwhile I will give you a short summary of it, if you would care? (Report handed in. *See* Appendix I., at end of Dr. Lorrain Smith's evidence.)

13586. Yes, that would be of service?—Generally speaking, I adopted the methods which have been employed by bacteriologists, especially by Dr. A. C. Houston, in working at this question, namely, the enumeration of bacteria in sewage at different stages of its treatment, and I have summarised those results in tables given in my report. Then I went into the further question to discover what was the number of the specific kinds of bacteria, anaerobic and liquefiers, as well as representatives of the more pathological varieties, and I have also tabulated the results in the report under the different headings. About the time I started these investigations I carried an investigation of more abstract interest in the first instance, but which after a time had a very considerable and practical importance. I consider this as a general principle, that a bacteria bed is efficient according to its power of reducing the number of microbes in the sewage which is poured over it. It seemed to me that this principle involved a certain anomaly. We accept the conclusion that chemical changes in the sewage are due to bacteria only, and at the same time we hold that the efficiency of the beds in producing these changes is directly measured by the extent to which the bacteria decrease in the sewage as it passes through the beds. The question then took this form:—At what rate do bacteria exhaust the pabulum present in suitable media? I investigated this point in the following way. I took a flask of ordinary broth used for growing the bacteria and diluted it in a series of flasks with sterile distilled water to various stages of dilution, until I got down to a very large dilution in the end. I placed in the flasks a culture of bacillus coli communis, which I had obtained from the water supply. I then watched the rate of growth, my object being to see if the bacillus would rapidly exhaust the pabulum and cease growing. To my surprise this method of exhaustion was an extremely slow one. I took observations for about two months, and even at the end of that time, as you will see in my report, I have recorded there were present in one flask 5,000,000,000, and the lowest record 1,500,000 per cubic centimetre. It was clear that as regards exhaustion of a pabulum such as that of meat broth bacteria of the bacillus coli group have very slight power. It seemed to me, therefore, that the process must be on some quite different basis in the bacteria beds, because in the double contact period of three hours each you have a reduction in the number of bacteria amounting to about 60 per cent. in several observations, and much higher in others. These two things, therefore, show that there was some agency at work in the beds not at work in the flasks. I considered whether the sewage in passing through the beds might be exhausted in the following way. I kept the flasks containing samples of the two effluents in the laboratory for a few days in order to see if the number of bacteria would multiply, and I have recorded the results. Two or three of those experiments were made, and they showed that after ten days even the numbers are practically beyond enumeration. I began to examine microscopically the deposit from the effluent, to ascertain what there might be in addition to bacteria, and I was struck by the number of infusoria—small animal forms which obtain their food in the shape of bacteria, and I have suggested that probably these small animals devour the bacteria and reduce their numbers. In the same situation one discovers worms and insects, whose food is the tissues of these small animals and their eggs. And if you examine the sediment which forms in a vessel where you allow these small forms to flourish you discover that they do deposit themselves in very large numbers. It seems to me, further, that this possibly would explain to some extent how the nitrogen disappears from the sewage; it is really converted into animal tissue, and part of it is deposited on the bricks and on the bottom of the bed. I noticed on the bricks used in the laboratory experiments there was always a deposit—a rapidly-formed deposit. I am looking forward to continuing these investigations in order to ascertain in various directions how far this biological element is involved in the process of purification which takes place.

13587. (*Chairman.*) Where the number of bacteria is found in the final effluent from purification processes to be greatly reduced, do you not think it may likely be that the number has diminished because of the absence of food?—That objection occurred to me. I kept the flasks containing samples of this final effluent for over ten days and discovered that the number went up again at once to a very large number.

13588. In closed vessels?—Well, in a flask stoppered with cotton wool.

13589. So that it was not the lack of food which prevented their growth?—I do not think so.

13590. Then your view would be that the higher forms of life which abound in certain stages of sewage treatment owe their existence to the bacteria which is forming food for them rather than because they are themselves purifiers of sewage?—Yes. Of course, I have not had an opportunity of going into this matter thoroughly. This occurred to me at the end, at the close of the investigations.

13591. You suggest to us that your interesting investigations have scarcely proceeded far enough for you to give us final conclusions?—Oh, no, by no means.

13592. There are forms which have different methods?—In any fluid which is exposed to infection of these forms I believe it is recognised that some appear earlier and some later?—Yes. There is a sort of regular cycle.

13593. The whole question of bacteria action is more or less new, but the point you have called attention to, the action of the higher organisms, has been very little investigated, I think?—Not very much.

13594. It appears to us that should be probed further, and inquiries should be made as to the action of vegetable growths in the sewage of polluted waters, and that particular form of investigation would be useful because these growths become visible to the eye?—Yes.

13595. It has been suggested to us that an effluent flowing through a channel registers upon the walls of that channel its effects?—Yes, and to find the maximum growth of those forms, to find the relation of them to certain conditions, would be one of the objects of my investigations.

13596. (*Dr. Houston.*) I am afraid, Dr. Smith, that you have anticipated most of my questions in your very able summary of your report. In regard to the bacilli in the effluents themselves these organisms are found in most sewage?—Yes.

13597. Was that due to the large dilution of the subsoil water?—I think probably some cause of that sort was at work. A curious point was they seemed t5 have multiplied in the later stages of the investigation at a period which coincided with an outbreak of typhoid fever in the town.

13598. You always observe a correspondence between th echemical and the bacterial results?—Yes.

13599. Does the percentage work out practically the same?—The average purification, according to Professor Letts' figures, was 57 per cent.; estimated by Kjeldahl's method, according to my results it would come out at 60 per cent.

13600. Could you give the Commission any idea why there was no nitrification in the effluents from these beds?—No, I really have no idea of my own.

13601. I mean purely from the bacteriological point of view?—No.

13602. There is nothing in the flora?—No.

13603. Then the cycle of events you describe in your report here begins with the multiplication of the bacteria, and then you think certain forms of infusoria

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appear, and then later on the bacteria are simply eaten up?—Yes, that is the theory.

13604. I think you found that the spores were reduced in the same proportion?—Yes.

13605. Almost identical?—Yes.

13606. Considering the hardy nature of spores as compared with the bacteria, it rather favours your view. It is rather a remarkable fact?—Yes, I think so.

13607. Have you any view as regards the enzymes in connection with purification?—No.

13608. Do you propose to study that?—Yes, certainly. One point I did not mention, which appears to me noteworthy. One of the results I secured by my series of experiments was that the coke beds show a greater number of bacteria than the brick beds; there were better results from the brick beds, showing that the increase in the number of bacteria is not the sole question at issue.

13609. It occurred to me there might be a little difficulty as regards your infusoria theory—perhaps you could explain it—as regards dry earth closets, because you can use the same earth again and again. Would you suggest that the infusoria would be concerned there?—I should not think so. In samples of soil, infusoria are not so plentiful.

13610. Do you think that the question of temperature may have any connection with this, because the difference in temperature between summer and winter is not accompanied by very great difference in the degree of purification or in the degree of reduction of microbes, which is not altogether in favour of the infusoria theory?—The temperature of these beds even in winter seems to be sufficiently high to encourage the growth.

13611. You have no way of counting the growth?—I have thought of doing it as one counts the corpuscles of the blood.

13612. If you could devise a method it would throw a considerable amount of light upon your theory?—No doubt it would, but you get them in colonies, and these colonies break up, and it would be a little difficult to know what the unit was in regard to certain forms.

13613. You would accept it as a broad fact that in the cold winter months the infusoria would be apt to be very few as compared with the summer months?—Yes, I should think so.

13614. (*Dr. Russell.*) In your report you incidentally allude to the important question as to the possible influence upon the health of the consumers of the shell fish in the Lough. You say, "It has been regarded as a matter of the greatest importance to prevent the introduction of shell fish into the market from beds situated in water polluted with sewage." Have you gone into that question?—I have lately examined a number of shell fish from the Lough, the report of which I placed before the Public Health Committee of the Corporation. I will hand in a copy of it if necessary. (*Handed in. See Appendix II. at end of Dr. Lorrain Smith's evidence.*)

13615. Was it an abstract inquiry as to the sporadic or occasionally epidemic effects of typhoid fever?—There was an instance occurred in the city where two children, I think, died.

13616. Inside the borough?—Yes.

13617. Can you give us an idea of the nature of the outbreak?—Perhaps Mr. Scott can.

Mr. Conway Scott's evidence.

(Mr. Conway Scott, C.E., executive sanitary officer of Belfast, here gave evidence in reply to Dr. Russell.)

13618. (*Dr. Russell.*) Can you tell us the nature of this outbreak?—Yes; the father and two children had been eating cockles; the two children died and the father was ill, but he did not die. The mother, who had taken none, I think, was not ill.

13619. The samples of the cockles were taken from the coast outside here?—We cannot definitely say.

13620. Were they cooked?—No, I think not. I think they eat them raw.

13621. What do they do that gives them the notion they cook them? Pour boiling water over them?—I don't know, to my knowledge they are usually eaten raw.

13622. We saw numbers of men yesterday with cockles, and they said they cooked them?—I am afraid they eat them raw.

13623. It was a fact that these people ate the cockles from the Lough?—We do not know exactly.

13624. They had bought them somewhere?—Yes, but we did not know where. Cockles taken from the Lough were sent to Dr. Smith. We had a number of other cases where there is pretty strong suspicion, too.

13624*. It is regarded as an acknowledged source of enteric fever?—I don't know that, but it is very suspicious that a great number of people after eating them afterwards take typhoid fever. I do not think it has been absolutely proved.

(*Dr. Russell.*) Thank you for your evidence.

(Dr. L. Smith's evidence continued.)

(*Witness.*) The line I took was an indirect one by determining the nature of the bacteria inside the shells of these cockles, and I also investigated the bacteria in cockles from the clean water. The details are given in the report I spoke of.

13625. And you found the microbes present?—Yes, and I made an injection experiment with a guinea pig, and it died within 48 hours.

13626. That was in the local shell fish?—Yes, so that I obtained positive evidence of three representative microbes.

13627. Were the cockles got from other sources, also?—Some of them were got in the waters of the Lough, and some were from water free from the suspicion of being contaminated.

13628. Have you examined the water in which these cockles grow?—I have never done any systematic investigation of that.

13629. I suppose there is little doubt what you would find if you examined the sea water? I suppose you would find a large number of microbes?—I suppose so.

13630. You infer if a delicate organism survives, then the more resistant must also survive?—Yes.

13631. You have finished your report, and it will be presented to the Corporation?—Yes.

13632. I see another interesting suggestion also that this decomposition of the ulva on the shores of the Lough and the passage back of the products of the decomposition is maintaining the growth of the weed?—Yes, I suppose that is so.

13633. Of course it gets washed away in winter, but its immediate effect might be to help the growth of the ulva that remains?—Yes.

13634. Have you made any observations as to the effects upon health by these deposits of ulva upon the banks?—No, I have made no observations.

13635. You do not live down there?—No.

13636. The use of cockles from the Lough I suppose was very prevalent?—It is difficult to get any exact knowledge. I think most of them are taken away.

13637. They are used for bait?—I suppose so.

13638. The crop of cockles must be very considerable in the Lough?——

(*Dr. Letts.*) I think the crop of cockles has increased in the Lough.

(*Dr. Russell.*) It was very striking, the number of men employed in getting them yesterday.

(*Dr. Russell.*) It is a most important matter in its way.

13639. (*Chairman.*) (*To Dr. Smith.*) Intestinal germs were clearly found in the cockles?—Yes.

13640. (*Mr. Stafford.*) (*To Witness.*) As a result of the treatment of sewage by the Corporation you find there has been a reduction in the number of bacteria by 80 per cent.?—Yes.

13641. Do you think that is a sufficient standard of purity, bacteriological purity?—Well, the position I take up is this. I think it is desirable to reduce it to the utmost practicable limits we can reach, and when others have succeeded there is no reason why we should not.

13642. What is the best result that has been obtained?—The highest bacteriological result?

13643. Yes?—I have known instances where the bacteria were reduced by 94 or 96 per cent.

13644. And you think it would be desirable to aim at a similar result in the Belfast sewage?—Yes, one would then increase the starvation of the weed.

13645. You would aim at that?—Yes.

13645*. And advise the Corporation to aim at that standard?—Yes, quite so. I don't know why our coke beds did so badly, because the result I am quoting was from a coke bed.

13646. But they admittedly have worked badly?—Well, they are not so good.

13647. In producing the result of 60 per cent. reduction?—Yes, it is rather bad leaving 40 per cent. It will have to be reduced very seriously before it can be said to be the best.

13648. In regard to the cockles question and shell fish generally, Belfast is a town which suffers a good deal from enteric fever? You yourself have made more than one report in connection with enteric fever in Belfast?—Yes.

13649. And if there was a large amount of enteric fever in Belfast, there would be a good deal of coli in the sewage?—Yes.

13650. Do you find that?—No, I found my results were rather negative. I no doubt would have found it if I had diluted the samples less.

13651. Did you make these examinations at a time that enteric fever was epidemic in Belfast?—Yes, the later series. There were nine in all, six by themselves and three separately. The three were later, and at that time I found coli fairly abundant, and that was the time that the epidemic was breaking out. Why the two facts should have corresponded I don't quite know.

13652. But they did correspond?—Yes.

13653. It would be very interesting to watch the outbreak of typhoid in relation to the presence of coli. You are, I understand, I presume you are, to carry on your work on that line later?—Yes.

13654. You are at present engaged in making investigations in connection with the prevalence of enteric fever?—Yes.

13655. Have you been able to arrive at any results in the present investigation?—Well, I have been working at the question of the life of the typhoid bacillus, and the soil, trying to find out how far it might be an endemic disease.

13656. Those investigations are hardly completed?—No, I should be very pleased to summarise them for the Commission when they are completed.

We shall be very glad to have them, it is very important to have them.

13657. (*Chairman.*) That would be at a later date necessarily?—Yes.

13658. Your earlier report on the subject was in regard to an epidemic of typhoid fever?—Yes.

13659. You connected it at that time, I think, with the water supply?—I thought I had sufficient evidence to do so.

13660. In fact, you did so?—Yes.

13661. You do not consider that the water supply of Belfast is responsible for the prevalence of enteric fever when it is not epidemic?—When I was conducting my investigations I had reason to believe so.

13662. While you were doing so, you connected it with the epidemic?—Yes.

13663. An existing epidemic?—Yes, there was strong circumstantial evidence. I investigated at that stage the question whether this water showed evidence of contamination.

13664. Since your observations of that time the Water Commissioners have got a new water supply?—They are getting a new one; it has been used for a certain part of the town on the County Down side, to what extent I don't know.

13665. Well, the supply which was the cause of this epidemic, has that been cut off?—No, but a good deal of work has been done in preventing contamination in the catchment area.

13666. Were you able to point out where the contamination arose?—Yes.

13667. There was a distinct house or houses?—Yes.

13668. Discharging their sewage into the catchment area?—Yes.

13669. Not very far from the catchment area?—Yes.

13670. But apart from that particular outbreak, do you attribute the constant prevalence of enteric fever to the water?—Well, it is very difficult to put one's finger on any definite cause which induces it. It is hardly possible to isolate one cause in that way; one attributes typhoid to a group of conditions, personal habit, cleanliness, soil, water, the food supply, and so on.

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13671. From your investigations you think there will be something in the condition of the soil?—Yes, I have gone into the condition of the soil which favours the growth of typhoid bacilli, and, generally speaking, I have found that the soil is not favourable to the growth of typhoid bacilli; there is a great difference in the conditions, as to moisture and so forth.

13672. And later on you will give us further information?—Yes, I shall be very pleased to do so.

13673. (*Dr. Russell.*) I suppose in sterilised soil typhoid would not live?—It would not live well, it does not increase, it is a mere question of survival.

13674. (*Chairman.*) Have you ever localised the presence of typhoid in the sewage?—No, I never tried to even.

We are very much obliged to you, Dr. Smith.

APPENDIX I. TO Dr. LORRAIN SMITH'S EVIDENCE.

Report to the Corporation of Belfast on a Bacteriological Investigation of the Experimental Contact Beds for the Treatment of Sewage.

THE NATURE OF THE SAMPLES.

The material of which the beds are composed consists in fragments of brick or coke, measuring from ½ to 3 inches in diameter. In the first series of nine observations, the samples were of sewage which had been in contact with bricks only. In the second series, the upper of the two beds was composed of coke and the lower of brick.

The sewage, after it had been screened and sedimented, was passed into the upper bed, and allowed to remain there for a period of three hours. It was then passed into the lower bed, and left for a similar period. We have, therefore, to deal with it at four different stages. (1) Sewage as it passes from the main sewer into the tank where sedimentation takes place. The samples taken at this stage naturally vary in their composition, and in many ways are not comparable with each other, or with the samples which are taken at the subsequent stages. (2) Sewage after it has been in the sedimenting tank for a period of 6-12 hours. The sample of this was taken as it passed over into the upper bed, and could therefore be compared strictly with (3), the sewage as it passed into the lower bed after it had been in contact with the bricks of the upper bed for three hours. Finally (4) a sample was taken of the sewage as it was leaving the lower bed to be poured into the Lough. Samples 3 and 4 are called respectively Effluent I. and II.

It is to be noted, therefore, that while the samples of crude sewage in the main sewer may differ from the three later samples, these three are strictly comparable with each other. Some hours elapsed (12-24) before the samples were available for analysis.

GENERAL NATURE OF THE PROCESS OF PURIFICATION.

The organic matter which is present in the sewage is the substance towards the removal of which the various processes used in the purification of sewage are directed. This matter is the natural food of bacteria, or small animal organisms, and the effect of bacteria upon it leads to the ultimate transformation of it into chemical substances which no longer serve the purpose of a pabulum. This process in nature proceeds slowly, and the claim which is advanced in favour of contact beds, as a method of sewage purification, is that in them a rapid exhaustion of the pabulum takes place. The stages of exhaustion of this food supply are stages in the process of purification, at the perfection of which sewage treatment aims.

QUESTION TO BE ANSWERED BY BACTERIOLOGICAL ANALYSIS.

The practical problem takes this form: "Is there any biological evidence that the contact beds produce exhaustion of the pabulum, and if this occurs, does it depend on bacteria or other organisms, or on both?"

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The beds contain not only bacteria, but vegetable and animal organisms, such as fungi, infusoria, worms, and insects. These are present in enormous numbers. The study of these organisms may be called the biological investigation of sewage treatment, and this method has the advantage of being a direct study of the process which gives rise to the chemical changes in sewage purification. It has limitations, however, in the fact that, as regards microbes, for example, it is impossible to grow many of the forms by any known method of cultivation. The results of enumeration of microbes are, therefore, an index of the amount of bacterial growth rather than an absolute measure. The chief fact which can be made out is the ratio of the numbers observed at the successive stages in the sewage treatment. This, we will see, is the important matter in the interpretation of the process so far as bacteria are concerned.

METHODS AND RESULTS.

The bacteria were enumerated by means of gelatine plates in the recognised manner. They were incubated at a temperature of 20° C., and the colonies were counted after 2-3 days' growth. The rule was followed of using, as far as possible, only those plates which contained not more than 20-30 colonies.

In the first of the following tables there are given nine observations on samples from the brick beds. The period of observation extends from January to April of this year. In a separate table I have placed the observations on three samples from the second set of beds, the upper of which was coke and the lower brick. These samples were taken during May and June.

The plates used for enumeration contained in all cases 1-100,000th and 1-1,000,000th of one c.c. respectively. Three plates were made of each dilution.

TABLE No. I.

Showing total number of Bacteria per c.c. present in nine samples from Brick Beds :—

———	Crude Sewage.	Screened and Sedimented.	Effluent from Upper Bed.	Effluent from Lower Bed.	Date of Sample.
1	2,500,000	6,600,000	7,600,000	6,500,000	6 January.
2	15,700,000	15,000,000	38,000,000	11,000,000	20 ,,
3	5,250,000	13,100,000	5,750,000	3,400,000	29 ,,
4	3,700,000	13,000,000	41,000,000	10 300,000	5 February.
5	2,150,000	186,000,000	143,000,000	87,000,000	12 ,,
6	6,500,000	12,600,000	9,300,000	6,800,000	19 ,,
7	3,300,000	2,000,000	4,300,000	1,600,000	3 March.
8	30,600,000	30,300,000	14,300,000	7,300,000	10 ,,
9	27,600,000	112,300,000	35,300,000	19,600,000	22 ,,
(A.)—Average of first nine brick beds	10,811,111	43,433,333	33,172,222	18,055,555	

We may discuss Table No. I. in the first instance. The general conclusion which is evident is that the numbers of bacteria come out in a perfectly regular order. In the crude sewage the numbers are low on the average, and in this series it is only the average results which need be taken into account. In the screened and sedimented sewage the numbers are very considerably higher; on the average, four times as high. The numbers in Effluent I. are slightly lower than those of the screened and sedimented sewage; while those of Effluent II. are less than half those present in the screened and sedimented. To this rule there is no exception. The effect of the contact is seen in each case in the reduction of the numbers of bacteria. Considering the amount of pabulum and the high temperature of the beds, it appears at first sight very remarkable that in such favourable conditions for multiplication of bacteria their numbers should have been reduced.

TABLE No. II.

Showing the total number of Bacteria per c.c. present in three samples from Coke Beds.

———	Crude Sewage.	Screened and Sedimented.	Effluent from Upper Bed.	Effluent from Lower Bed.	Date of Sample.
10	168,000,000	120,000,000	103,000,000	117,000,000	17 May.
11	53,000 000	125,000,000	75,000,000	79,600,000	31 ,,
12	uncountable	70,000,000	41,000,000	40,000,000	7 June.
(B.)—Average of last three, coke beds	110,500,000	105,000,000	73,000,000	78,866,666	
(C.)—General average	28,936,363	58,825,000	43,129,166	33,258,333	

The numbers of bacteria follow the same rule in the observations on the combination of coke and brick beds, but much less clearly. The effect of the beds is to reduce the numbers, but this does not occur to such an extent, nor with the same regularity as in the brick bed series. The total numbers also are very much higher than in the former series. This increase may be partly due to the fact that the samples were taken in May and June, when naturally bacterial growth was much more active than during the earlier months of the year. It might, however, be due to a lack of efficiency on the part of the combination of coke and brick beds as compared with that of two brick beds. That this is so is proved by the results of the chemical analysis given in Professor Letts' report, which show that here the purification is, according to all the three standards applied, less complete than that of the brick beds. As regards the decrease in bacteria, we have here a fall of 26 per cent., as compared with 58 per cent. in the brick beds. The number of samples, however, is too small to give any decisive conclusion. This result, however, so far as it goes, points to the fact that the agency which brings about purification leads to a fall in the number of bacteria. As yet no standard has been agreed upon according to which the efficiency of the purification may be estimated by the effect of the contact in causing this fall; nor has it ever been explained why with efficiency of purification there should be a fall in the number of bacteria. It might even seem desirable, as Dr. Houston suggests, that "an effluent partially purified should carry with it the bacteria which have been engaged in the work of purification, but experience has shown that the bacterial beds which yield the best chemical results yield also the best results bacteriologically."

I will later describe a prolonged series of experiments which I have carried out in the present investigation with a view to discovering the meaning of this anomaly. In the meantime it is of great interest to compare the results of the above tables with those of two other observers.

From one of the tables given by Dr. A. C. Houston in his Report to the London County Council (May 24th, 1900) I have compiled the following average:—

Crude Sewage.	Effluent from Primary Coarse Bed of Coke. Series A.	Effluent from Secondary Coarse Bed of Coke. Series A.	Effluent from Primary Coarse Bed of Coke. Series B.	Effluent from Secondary Fine Bed of Coke. Series B.
7,090,000	2,080,000	1,910,000	2,700,000	1,440,000

In some of Dr. Houston's other tables the results show a much less marked effect on the numbers of bacteria. For the purpose of comparison, however, I prefer to take the most successful amongst his series of experiments.

In Professor Boyce's Report on the action of the contact beds at West Derby, he gives the following average:—

Number of Bacteria in Crude Sewage. (Average of 29 Analyses.)	Number of Bacteria in the Effluent from the Final Contact Beds. (Average of 36 Analyses).
1,090,726	614,158

The reduction in the numbers of bacteria in Dr. Houston's table is still more striking than that observed in the table I have given. The lowest figure which he obtained was a fall from 7,000,000 to 400,000, a decrease of 94 per cent. of the total number. The largest reduction in my table is that of March 22nd, when the numbers fell from 112 millions to 19·6 millions per c.c., implying a loss of over 80 per cent. In Professor Boyce's observations the fall on the average is 44 per cent. The total number of microbes in the Liverpool sewage is approximately 1 million, in the London sewage 7 millions, and in the Belfast sewage, after sedimentation, 43 millions.

The average fall in Houston's series implies a loss of about 80 per cent. of the total bacteria, and at the period corresponding to these observations the percentage purification as estimated by the oxygen absorb test was on the average 85 per cent. (Clowes). In my series in Table I. the fall in bacteria implies a loss of nearly 60 per cent., and for this period the percentage purification according to the oxygen absorbed test was 69 per cent. (Letts).

There is not yet, however, a sufficient number of results published to show decisively in how far the reduction in bacteria may be regarded as a measure of the efficiency in purification by the contact beds. The results I have given show how the brick beds now examined compare with the coke beds examined for the London County Council, and the coke beds of the Liverpool Corporation, in regard to this point.

It is clear that to arrive at a true conception of the process which brings about purification, it is necessary to consider how far the decrease of bacteria, observed as a result of the contact, is due to the multiplication of bacteria themselves, and their demands for food supply. This might conceivably lead to an exhaustion of the pabulum, and subsequent decrease in their numbers. That this hypothesis is problematical seems evident from the fact that in the second series of observations on the coke and brick beds the exhaustion of pabulum was less marked, while the bacteria consuming it were more numerous than in the samples in the first series. If bacteria are the sole agents which bring about the chemical changes in the sewage, one might expect that the greater the number of bacteria the more advanced would be the changes in which purification consists. The questions which arise out of this difficulty regarding rate of growth and rate of exhaustion of pabulum could be answered only by direct observations on the subject, and this I proceeded to carry out in the following way.

To a flask (A) containing 90 c.c. of sterile distilled water I added 10 c.c. of a broth culture of bacillus coli communis in active growth. From flask (A) 10 c.c. of the mixture were added to 90 c.c. of sterile distilled water in flask (B), and so on, forming a series in which each succeeding flask had the broth diluted to 1-10th of the strength of the flask before it. Thus A contained in each c.c. 1-10th of a c.c. of broth, B contained 1-100th, C 1-1,000, D 1-10,000, E 1-100,000, and F 1-1000,000.

Regular observations of the numbers present in these six flasks were made. The bacillus coli communis was selected because it is one of the commonest bacilli in sewage. It shows its power of disintegrating albuminous substances by breaking them up into indol. It is further also very easily cultivated. The plates were made with agar incubated at 37°C., and enumerated after 12-24 hours' growth. Four plates were planted for each enumeration. In the following table are given the results of these observations:—

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TABLE III.

Showing the rate of growth of b. coli. comm. in relation to the food supply present. The numbers represent the number of colonies per c.c.

—	Flask A.	Flask B.	Flask C.	Flask D.	Flask E.	Flask F.
16 January -	9,100,000	910 000	91,000	9,100	910	91
17 " -	114,000,000	52,400,000	25,000	1,200	1,350	23
18 " -	120,250,000	209,000,000	22,900,000	20,700	30,500	64
19 " -	259,000,000	219,000,000	20,800,000	1,400,000	2,300,000	205
20 " -	430,000,000	230,000,000	40,000,000	10,600,000	1,800,000	4,400
21 " -	340,000,000	250,000,000	40,000,000	13,200,000	11 300,000	192,000
22 " -	595,000.000	240,000,000	85,000,000	20,000,000	26,000,000	3,100,000
23 " -	6[illegible]0,000 000	310,000,000	140,000,000	19,000,000	21,500,000	7,500,000
24 " -	480,000,000	490,000,000	380,000,000	50,000,000	38,000,000	19,000,000
25 " -	520,000,000	204,000,000	65,000,000	65,000,000	85,000,000	11,000,000
26 " -	542,000,000	2,400,000,000	45,000,000	96,000,000	80,000,000	11,500,000
27 " -	1,850,000,000	1,050,000,000	115,000,000	25,000,000	30,000,000	12,000,000
28 " -	—	1,500,000,000	450,000,000	30,000,000	55,000,000	35,000,000
1 February -	1,750,000,000	245,000,000	24,000,000	—	65,000,000	16,500,000
2 " -	4,700,000,000	1,100,000,000	65,000,000	25,000,000	35,000,000	20,000,000
7 " -	—	2,100,000,000	85,000,000	100,000,000	130,000,000	60,000,000
16 " -	5,600 000,000	1,150,000,000	135,000,000	60,000,000	40,000,000	35,000,000
28 " -	5,250,000,000	3,500,000,000	80,000,000	80,000,000	40,000,000	15,000,000
9 March - -	2,700,000,000	250,000,000	85,000,000	50,000,000	8,000,000	Too dilute.
23 " - -	5,400,000,000	290,000,000	69,000,000	6,500,000	1,500,000	Too dilute.

The experiment prolonged itself beyond all expectation, and even after two months there was little sign of exhaustion.

From this series of experiments it is clear that as regards exhaustion of a pabulum such as that present in meat broth, bacteria of the bacillus coli group have a very slight power. It is also clear that the reduction in the number of ordinary bacteria, seen after short periods of contact, must depend on other factors than their power of exhausting the pabulum. Manifestly also when the numbers reach a certain point variation is somewhat slowly brought about.

It is unnecessary to say that it would be desirable to continue this method of study of the rate of growth with other forms of bacteria, but the time and labour involved in this six-fold experiment were, as it came about, no small matter.

The conclusion was farther supported by a series of direct observations by chemical methods on the exhaustion of food by the bacteria of the sewage. As pointed out, the exhaustion of the food consists in the transformation or dispersion of the organic nitrogen. The food nitrogen exists in the form of unoxidised nitrogen, and the disappearance of this from a fluid medium in which bacteria are growing can easily be ascertained by the application of Kjeldahl's method.

In the first series of experiments I inoculated a broth diluted to 1-10th, the normal strength—*i.e.*, containing on the average about 20 parts of nitrogen per 100,000—with a loopful of sewage, and left it to grow at room temperature for five days. Even after this long period the unoxidised nitrogen had never decreased below 86 per cent. of the original. It was frequently about 95 per cent., and often there was no appreciable loss. In the chemical section of this investigation, which is given in Professor Letts' Report, it is shown that in the contact beds the unoxidised nitrogen of the sewage is reduced to 5·7 per cent. of the original.

The experiments were carried out in a variety of ways. I inoculated the broth with a loopful of sewage, or made a mixture of equal parts of sewage and broth. The following are the details of some of the experiments:—

Experiment on the Disappearance of Unoxidized Nitrogen from 20 c.c. Broth Inoculated by a Loopful of Sewage grown 5 days.

(1.) Inoculated from crude sewage - - - - - - -	6·9 per cent loss. 11·4 "
(2.) Inoculated from screened and sedimented - - - -	9·6 " 8·6 "
(3.) Inoculated from Effluent I. - - - - - - - -	5·5 " 5·8 "
(4.) Inoculated from Effluent II. - - - - - - - -	10·3 " 9·4 "

Average loss of nitrogen 8·4 per cent.

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In this experiment 20 c.c. of broth contained ·04 grammes of unoxidised nitrogen.

The same experiment was repeated with broth of a similar composition, and a parallel series with broth diluted ten times with distilled water. The results were similar. The average loss in nitrogen was 12·2 per cent. after five days. This was the highest value reached in any experiment in this series. The results, however, were sometimes entirely negative, as may be seen from the following experiment:—

A mixture of broth and sewage in equal parts was kept for five days. The value in unoxidised nitrogen of 20 c.c. of the mixture was determined at the beginning of the experiment by double analysis. The results are expressed in c.c. of 1-10th normal ammonia, and were the following:—

			c.c. of $\frac{1}{10}$ NH_3			c.c. of $\frac{1}{10}$ NH_3
Crude sewage	20 c.c.	=	13·38	after five days' incubation	=	13·1
Screened and settled	20 c.c.	=	12·83	,, ,,	=	12·9
Effluent I.	20 c.c.	=	13·10	,, ,,	=	13·0
Effluent II.	20 c.c.	=	12·77	,, ,,	=	12·0

It is to be noted here that there is no loss except in the case of the last, where a loss of about 5 per cent. has occurred.

This experiment was repeated with practically the same result. The conclusion was, therefore, that, though undoubtedly a certain amount of unoxidised nitrogen may disappear as a result of bacterial growth, after periods lasting five days, the highest average is not more than 12 per cent.

In view of the partly negative character of these results, I repeated the experiment in another form. I brought the broth into contact with brick taken from the brick beds, and with suitable specimens, *i.e.*, those from the lower layer of the beds, I found a very marked disappearance of the unoxidised nitrogen from the dilute broth.

The following experiment shows the kind of result which was obtained. The broth was again diluted with distilled water, so as to contain about 20 parts of unoxidised nitrogen per 100,000. It is important to note in connection with these observations on the disappearance of unoxidised nitrogen, that the chemical examination of the process as it takes place in the contact beds shows that the disappearance of nitrogen in the unoxidised form is not associated with its reappearance in the effluent in the form of oxides.

Table IV.—Result of experiments to determine the loss of unoxidised nitrogen in dilute broth when in contact with the brick beds. Unoxidised nitrogen = 20 parts per 100,000. Loss expressed in percentages of the original amount.

—	In 22 Hours.	46 Hours.	70 Hours.	—
Upper bed, 6 inches deep	20 per cent.	23·7 per cent.	32·1 per cent.	
,, 18 ,,	26·7 ,,	34·8 ,,	30·1 ,,	Some sediment.
Lower bed, 6 ,,	25 ,,	28·2 ,,	32·1 ,,	
,, 18 ,,	54·5 ,,	63·2 ,,	71·2 ,,	
Recharged after 4 days' rest.				
Upper bed, 6 inches deep	19·1 ,,	25 ,,	23 ,,	
,, 18 ,,	24·72 ,,	22 ,,	27 ,,	
Lower bed, 6 ,,	21·2 ,,	14 ,,	—	Sediment.
,, 18 ,,	38·9 ,,	56 ,,	53 ,,	

The experiment was repeated several times, with the uniform result that a marked disappearance of unoxidised nitrogen from the solution took place.

The results of the chemical analysis of the sewage by Professor Letts are as follow:—

Percentage Purification as shown by Kjeldahl's method.

Highest result after second contact	-	77 per cent of purification.
Average of all experiments	-	57 ,, ,, ,,
Brick beds	-	60 ,, ,, ,,
Coke beds	-	50 ,, ,, ,,

This set of results shows that we can in a measure locate the agency which has the strongest effect in causing the disappearance of unoxidised nitrogen. It is especially associated with the bricks of the deeper part of the lower bed. The agency, however, is here merely a degree or more efficient than that associated with the other bricks. In each case there is a remarkable disappearance of unoxidised nitrogen. The only points about the more efficient bricks which I observed was that they were more richly covered with sediment consisting of the vegetable and animal organisms already referred to. In the vessels in which the bricks were placed for the purpose of testing their action on the dilute broth, a copious layer of sediment, similar to that on the bricks, formed at the bottom. This when analysed (Kjeldahl), showed large quantities of nitrogen in the unoxidised form. The following experiment gives the details of one such observation.

The broth, after having been in contact with the bricks for six days, was taken for analysis in two portions. One portion was filtered, and 50 c.c. of the filtrate were put in each of two flasks and analysed for nitrogen. The filtrate was found to contain only 35 per cent. of the unoxidised nitrogen of the original solution, or, to keep to our former method of expression, there had been a loss of 65 per cent. of the original unoxidised nitrogen. On the other hand, portions of the broth which were not filtered, and which purposely were made to contain a large amount of sediment, yielded unoxidised nitrogen per c.c. amounting to more than 150 per cent. of that in the original diluted broth.

On these grounds, therefore, it seems clear that in the plant and animal life associated with the surface deposit on the bricks there is an agency which has the most striking power in causing the disappearance of unoxidised nitrogen from solution; whereas in the former experiments, when dealing with inoculation of the broth with sewage bacteria, only 12 per cent. of the nitrogen disappeared; in contact with the bricks the broth shows a loss of a great proportion of its nitrogen, sometimes amounting to 70 per cent. The bacteria alone have at the best a moderate and more slowly acting power of dispersing the food nitrogen. The

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vegetable and animal organisms which occur along with the bacteria absorb organic matter directly into their own bodies, and also devour multitudes of bacteria. That this is the most reasonable way of explaining the disappearance of the bacteria in the sewage passing through the contact beds seems most probable when we consider the capacity for bacterial growth which the various samples of the sewage actually possess. To observe this it is necessary only to keep the samples at a favourable temperature, and make subsequent enumerations of the bacteria to be found in them. The following table gives the details of three observations of this kind. The flasks of sewage were kept at room temperature, *i.e.*, about 20deg. C., sealed with sterilised cotton wool. The colonies were enumerated as before by means of gelatine plates.

TABLE No. V.

Showing total number of Bacteria per c.c. growing in kept Samples of Sewage.

SAMPLE OF 17TH MAY.

—	DATE.	Crude Sewage.	Screened and Sedimented.	Effluent I.	Effluent II.
1	18 May - - -	168,000,000	120,000,000	103,000,000	117,000,000
2	20 ,, - - -	uncountable	uncountable	uncountable	uncountable
3	22 ,, - - -	,,	,,	,,	,,
4	25 ,, - - -	,,	,,	3,500,000,000	1,250,000,000
5	27 ,, - - -	2,800,000,000	,,	500,000,000	650,000,000

SAMPLE OF 31ST MAY.

—	DATE.	Crude Sewage.	Screened and Sedimented.	Effluent I.	Effluent II.
1	1 June - - -	53,000,000	125,000,000	75,000,000	79,600,000
2	3 ,, - - -	uncountable	uncountable	uncountable	uncountable
3	5 ,, - - -	,,	,,	,,	,,
4	7 ,, - - -	,,	,,	,,	,,

SAMPLE OF 7TH JUNE.

—	DATE.	Crude Sewage.	Screened and Sedimented.	Effluent I.	Effluent II.
1	8 ,, - - -	uncountable	70,000,000	41,000,000	40,000 000
2	10 ,, - - -	,,	uncountable	uncountable	uncountable
3	13 ,, - - -	,,	,,	,,	
4	15 ,, - - -	,,	,,	,,	,
5	17 ,, - - -	,,	3,500,000,000	2,500,000,000	1,400,000,000
6	19 ,, - - -	1,300,000,000	spoiled	200,000,000	100,000,000
7	24 ,, - - -	500,000,000	1,800,000,000	5,000,000	8,000,000

By the phrase "uncountable" I mean that when the sewage had been diluted 100 million times 1 c.c. of the liquid gave a growth of colonies too close to be enumerated with accuracy. It seemed to me to little purpose to continue the dilution to higher stages. The general conclusion is perfectly clear that the capacity for sustaining bacterial growth is in no way represented at its maximum by the numbers which are observed in the fresh samples of sewage. This series of observations further confirms the experiments on the power of bacteria alone in exhausting the food pabulum. Apparently in the case of sewage kept in this manner, a period of a week to a fortnight must pass before the number of bacteria show a sensible reduction, and the decrease is seen more especially in the samples of the effluents.

The agency, therefore, in the contact beds which brings about a reduction in the number of bacteria is largely something quite different from any general power of mutual destruction among bacteria, such as might arise from their overgrowth, or from their exhaustion of the food supply.

The question might be raised, "Are these changes not due to the growth of a special bacterium which cannot be cultivated on artificial media, and whose growth is such as to prevent the growth of other microbes?" This complex hypothesis suffers from the fact that it cannot be tested. It would seem remarkable that the growth of a bacterium in the beds should suddenly not only arrest the increase of the other bacteria already in the sewage, but should actually cause a diminution to a very marked extent in their numbers. A further remarkable fact is that the same samples of sewage effluent in which we suppose this form of diminution has occurred, should, if kept in a flask in the laboratory, soon show unnumbered millions of bacteria per c.c. of the cultivable kind. It seems more natural to conclude that we have to deal with some agency other than bacteria which has the power of consuming them, and which has its habitat on the surface of the brick or coke fragments. The fact that the power of consuming nitrogen was so remarkable associated with the lower layers of the second beds gives confirmation to this idea.

It is well known that amongst the forms of life which occur in any solution which contains organic matter, and which is left exposed to the action of the small organisms commonly distributed in nature, a certain cycle is observed in the order of their appearance. One form succeeds and replaces another in a definite manner, those forms which have the most rapid power of multiplication becoming naturally predominant at first, and the more slowly multiplying appearing later. Amongst the first to appear are the bacteria, since they have specially rapid power of growth. Should the conditions favour, as they usually do, the growth of infusorians, these begin also to appear. Those forms which absorb their nourishment from food matter in solution occur along with the bacteria. Later, ciliated

forms appear, which have the power of ingesting food particles, and, especially, which devour bacteria. As a result of their appearance in force, the numbers of bacteria are rapidly reduced. One form of infusorian succeeds another under the action of causes which are very little understood, but a definite order is maintained. As conditions become unfavourable for any of the forms, they become encysted and drop to the bottom of the fluid, forming a layer of sediment.

There is thus a certain cyclical order in which the forms of life appear, and one of the events which takes place early in this process is a more or less complete approach to extermination of the bacteria. That this well-known cycle of events occurs also in the purification of sewage seems highly probable. On examining microscopically the sediment which is found at the bottom of the beds and on the surface of the bricks, we discover the bacteria and the active and encysted infusorians in large numbers, including the forms which absorb their food in solution, and the ciliated forms which devour bacteria. There are also multitudes of oligochaeta and nematode worms which find their food and deposit their eggs in the sediment. Correlated to this microscopic evidence we have the outstanding fact that in the contact beds the bacterial forms are rapidly disappearing. We have, therefore, apparently this cycle of events. The food material in solution is first absorbed by bacteria and certain infusorians. These become in turn the food of higher forms which are able to ingest solid particles. If we are right in recognising these events as occurring in the contact beds, the great destruction of the bacteria which is always observed indicates that they constitute an important part in the changes which are taking place. In the present state of invesigation it is impossible to go further in the interpretation of the process. The part which the infusorians, worms, etc., take demands further research; but in the time at my disposal it has not been possible to carry the work further than thepointI have indicated. To complete the evidence which I have been gathering, I should have valued the opportunity of examining bacteriologically a contact bed in the condition described by sanitary engineers as "sick." In this condition the bed ceases to exercise its power of purification absent from an effective bed, and it further loses its swarms of insects (podura aquatica). The opportunity of making an examination of a bed in this condition has not offered itself. The interesting point would be to discover the relation of "sickness" to the cyclical appearance of animal forms which I have described.

ANAEROBIC BACTERIA.

In addition to the enumeration of aërobic bacteria in the sewage, I made an enumeration of the anaërobes. The gelatine plates were made at the same time as those for the aërobes. They were transferred to a Bulloch's anaërobic chamber, in which a quantity of pyrogallate of potash was exposed in solution in an open vessel. A current of lighting gas was passed through the chamber, and it was then sealed, and placed in the incubating room at 20°C. for about a week. The chief interest of these observations is to show that the decline in the numbers of bacteria which takes place in the sewage as it passes through the contact beds is not confined to the aërobes. In the Belfast sewage the number of anaërobes is relatively low. For example, in the screened and sedimented sewage the average number of aërobes is 43 millions per c.c., while the anaërobes number only 25 millions. A large number of aërobes are so-called "facultative anaërobes," *i.e.*, they can live in the anaërobic conditions, and there must have been considerable overlapping in the numbers of the two kinds. It is further of great interest to observe that the same law holds in regard to the reduction of the numbers, and, indeed, an almost identical effect has occurred.

—	Screened and sedimented bacteria per c.c.	Final effluent bacteria per c.c.	Loss.
	Millions.	Millions.	Per cent.
Aërobic - - -	43	18	58
Anaërobic - -	25	12	52

This identity of effect suggests that the chief part of the microbes appearing as anaërobes have already appeared as aërobes in the former enumeration, and that the number of microbes which are able to grow only in the anaërobic atmosphere is relatively small. Confirmation of this idea is further obtained by comparing the aërobic and anaërobic enumeration results for the three samples from the combination of coke and brick beds. The bacterial flora of the contact beds seems predominantly aërobic and facultatively anaërobic.

TABLE No. VI.

Showing the number of Anaërobes per c.c. in the Samples of Sewage.

—	DATE.	Crude sewage.	Screened and settled.	Effluent I.	Effluent II.
BRICK BEDS:—					
1	6 January - - - -	1,400,000	uncountable.	3,200,000	6,000,000
2	20 " - - - -	6,900,000	16,000,000	37,000,000	12,000,000
3	29 " - - - -	3,800,000	4,500,000	19,000,000	13,000,000
4	5 February - - -	7,000,000	62,000,000	27,000,000	34,000,000
5	12 " - - - -	3,000,000	58,000,000	31,000,000	25,000,000
6	3 March - - -	less than 100,000	700,000	4,000,000	2,500,000
7	10 " - - - -	500,000	21,000,000	3,500,000	500,000
8	22 " - - - -	6,500,000	36,500,000	8,500,000	3,500,000
	Average - - -	3,650,000	25,200,000	16,600,000	12,040,000
COKE BEDS:—					
1	17 May - - - -	4,500,000	5,500,000	1,000,000	2,000,000
2	31 " - - - -	10,500,000	4,000,000	5,000,000	2,000,000
3	7 June - - -	uncountable.	2,500,000	1,000,000	6,000,000
	Average - - -	5,000,000	4,000,000	2,330,000	3,300,000
AVERAGE OF TOTAL -		4,000,000	19,400,000	12,700,000	9,680,000

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CONSIDERATIONS SUGGESTED BY THE FOREGOING OBSERVATIONS.

The bacteriological investigation of the process of purification in the contact beds shows that the agency at work differs essentially from a simple growth of bacteria in a fluid containing their food. The change which takes place in the sewage is not dependent simply on the growth of bacteria in the sewage, but occurs before the maximum of bacterial growth has been reached. From a study of the exhaustion of artificial media, it has been shown that occasionally results may be obtained by bacterial growth, proving that unoxidised nitrogen has been dispersed. In this dispersion the nitrogen is doubtless in the gaseous condition. Data on this subject are furnished in the chemical report, showing that 12 per cent. of the nitrogen which is dispersed from the sewage could be accounted for in this way.

In the second place, it was found that, associated with the bricks which were covered with a sediment of plant and animal organisms, there was a great power of throwing nitrogen out of solution. The meaning of this, which I have suggested, is that the nitrogen is absorbed directly into the bodies of these organisms to form their tissues or indirectly in the form of microbes, which are reduced in number in a very remarkable manner during the passage of the sewage through the beds. The nitrogen which disappears in this latter manner is partly stored up in the bed in the form of a deposit or sediment, and is partly carried off in the bodies of insects, worms, etc. In this form some of it no doubt may pass into the Lough, where ultimately its carriers become the food of their natural enemies. To have, therefore, as perfect as possible a form of contact bed, the conditions must be favourable to both agencies, the bacteria and the small plant and animal life. Since it has been found that the activity in bacterial destruction is an index of efficiency in purification, bacteriological analysis must in the meantime adopt this as the standard of efficiency. In the present investigation, if we compare the results of contact with the brick beds with those of the coke and brick beds, according to this standard we have another instance of the fact that where there is deficiency in purification, the reduction in the number of bacteria is smaller in amount.

OBSERVATIONS ON THE PRESENCE OF LIQUEFYING BACTERIA.

The investigation of liquefying bacteria is one of the recognised methods which gives information as to a certain though varied type of bacteria. It is interesting in regard to liquefiers, as in regard to anaërobes, to compare the ratios with those seen in the aërobic enumeration. In the enumeration of the total aërobic bacteria, it was seen that in passing through the beds there was a loss of 58 per cent. In this table the fall is still greater, viz., from 3 millions to 1 million, implying a loss of about 70 per cent. In the coke and brick beds the loss was only 27 per cent. on the average, but the total numbers of liquefiers per c.c. of sewage were curiously reduced compared with those in the earlier (brick bed) series. It is worth while to have this comparison in tabular form.

Proportion of Liquefiers amongst the total (Aërobic) Bacteria in the Samples of Sewage.

Beds.	Crude Sewage.	Screened.	Effluent I.	Effluent II.
	Per cent.	Per cent.	Per cent.	Per cent.
Brick	14	7·6	5	6
Coke and brick	under 1	1·4	4	3

From both series it is apparent that the greatest increase in the bacteria during the sedimentation of the sewage is not of the liquefying variety. In the first series it falls from 14 per cent. to 7·6 per cent. of the total. The increase has been chiefly of the non-liquefying variety. In agreement with this also we find the numbers of liquefiers per c.c. in the two series are much closer to each other than the total numbers.

TABLE No. VII.

Showing the number of Liquefying Organisms per c.c. present in Samples of Sewage.

—	Date.	Crude Sewage.	Screened and settled.	Effluent I.	Effluent II.
Brick Beds:—					
1	6 January	—	1,300,000	600,000	1,300,000
2	20 ,,	1,550,000	850,000	4,500,000	2,000,000
3	5 February	50,000	180,000	165,000	70,000
4	12 ,,	700,000	5,500,000	850,000	1,350,000
5	19 ,,	2,000,000	4,000,000	2,500,000	2,000,000
6	3 March	2,000,000	1,500,000	1,500,000	500,000
7	10 ,,	7,000,000	11,000,000	500,000	500,000
8	22 ,,	1,000,000	2,500,000	2,500,000	1,500,000
	Average	1,780,000	3,350,000	1,641,000	1,140,000
Coke and Brick Beds:—					
1	7 May	100,000	150,000	150,000	300,000
2	31 ,,	1,500,000	2,500,000	3,500,000	1,000,000
	7 June	—	2,000,000	2,000,000	2,000,000
	Average	800,000	1,550,000	1,850,000	1,100,000

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It is interesting to find that there is no special increase of the liquefying bacteria. Should the bacterial growth in the beds be the sole cause of the disintegration and dispersion of nitrogenous bodies, one would expect to find that the liquefying bacteria would have increased out of proportion to the other forms. They are generally regarded as possessing to a pre-eminent degree the power of distinguishing albumens. Contrary to this view, we find that the relative increase of the liquefiers is a good deal less than that of the non-liquefying variety. The liquefiers which are 14 per cent. of the bacteria in crude sewage (14·5 per cent. London sewage) are only 7·6 per cent. in the greatly multiplied numbers of the sedimented sewage. This result would point, therefore, to conditions in the sewage which favour the growth of bacterial forms other than the liquefying varieties. Confirmation of this view of the matter is found in the negative result of Houston's experiment on the effect of charging a contact bed with large quantities of a cultivation of sewage proteus. He found that this in no way added to the purifying power of the bed. (Report to London County Council, May 1900, page 75.)

On the other hand, the exterminating agency in the brick beds does not specially affect one species of bacteria more than another. The liquefiers remain in about the same proportion throughout the destructive period (5—7 per cent.)

Dr. Houston's results give the following ratios:—

Ratio of liquefiers to total number of bacteria aërobes.

Crude Sewage.	Primary Coke Bed Effluent. (6 Feet.)	Secondary Coke Bed Effluent. (6 Feet.)
14·5 per cent.	12 per cent.	20 per cent.

This curious rise of 20 per cent. indicates two possibilities. (1) There was increase in the numbers, or (2) the destructive agency was harmless to the liquefiers. The total number of bacteria fell to 60 per cent. in the second effluent, and 12—14 per cent. of the bacteria in the original sewage became 20 per cent. in the reduced numbers of the second effluent. The absolute number of liquefiers had remained stationary. On comparing these with my own results it would seem more probable that the liquefiers had increased at a special rate, and thereby counteracted the process of destruction. From this line of observation we may expect to get information as to the mode of working of the bacteria-destroying agency and, also on the question whether the bacteria which escape destruction continue multiplying at their usual rate. The conditions in the London experiments have obviously been in some way different from those I have investigated.

AËROBIC SPORES.

TABLE VIII.

Number of Aërobic Spores per c.c. in Sewage Samples.

—	Date.	Crude Sewage.	Sedimented Sewage.	Effluent I.	Effluent II.
Brick Beds:—					
1	6 January	—	220	2	5
2	20 ,,	240	620	220	220
3	29 ,,	—	112	43	98
4	5 February	93	110	118	70
5	12 ,,	39	55	51	69
6	3 March	166	204	209	68
7	10 ,,	8	22	25	19
	Average	109	192	95	73
Coke and Brick Beds:					
1	7 May	8	35	31	50
2	31 ,,	41	41	44	24
3	7 June	45	15	24	5
	Average	31	30	33	26

There is not much information to be gathered from the results as regards spores. The total numbers are so small in the Belfast sewage that it would hardly be justifiable to draw any conclusions. Generally speaking, the formation of spores is supposed to take place in any medium in which the conditions are unfavourable for a vegetative existence. The paucity of spores in the Belfast sewage, and the reduction of their number on the whole, as the sewage passes through the beds, indicates that the particular kind of unfavourable condition which conduces to spore formation has not been set up at any point. In the London raw sewage for one spore there were 21,000 bacteria in the vegetative form. In the Belfast crude sewage there is one spore to 100,000 bacteria, and in the sedimented sewage one in 200,000 bacteria, or thereabouts. The reduction on the average in the number of spores in Effluent II. as compared with those in the sedimented sewage implies a loss of 60 per cent. This is almost identical with the reduction in the total number of bacteria in these samples.

BACILLUS COLI COMMUNIS.

The investigation of b. coli communis was carried out by Klein's method of planting the bacteria on the surface of phenolated gelatine. The dilutions used were 1 in 10,000 and 1 in 100,000. In the earlier period it was

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difficult to get evidence of the bacillus at this dilution. In January and the early part of February the numbers were invariably less than 1 in 10,000. A large number of colonies were planted out, but I failed to find bacilli which answered to the outstanding tests (indol, gas, milk clotting, etc.). Only once was there 100,000 per c.c., and the average, including some very doubtful forms, was in the positive observations about 50,000. Considering the paucity of these bacilli it is impossible to draw any conclusion as to the effect of the contact bed upon them. One important point remains to be noted. There was a distinct increase in the coli-form bacilli in the later samples. The following were observed in the sample of May 31st:—

Number of Bacillus Coli Communis per c.c.

	Crude Sewage.	Sedimented.	Effluent I.	Effluent II.
31st May - - - - -	300,000	400,000	400,000	200,000

BACILLUS ENTERITIDIS SPOROGENES.

Observations were made on each set of samples in regard to this bacillus also, which like b. coli communis is of intestinal origin. Klein's method of isolating it was used, and the sewage was diluted according to the rule laid down by Houston. The evidence of its presence also was very scanty, and the results were parallel to those regarding b. coli communis. In the earlier observations there was occasionally some evidence in the milk tubes of imperfect clotting and whey formation; but it was not till late in the investigation, i.e., in May and June, when evidence of b. coli became clear, that the milk tubes showed the typical ragged clot, and clear whey and gas, associated with the growth of b. enteritidis sporogenes. The following is the record of the observations:—

6th January.—Nil.

20th January.—Nil.

29th January.—Imperfect clots only; no distinct separation of whey in tubes containing ·1 c.c. of sewage.

5th February.—Indistinct clotting = negative.

12th February.—Nil.

19th February.—Clots with some watery whey, no gas, in ·1 c.c. tubes.

3rd March.—Atypical clotting, &c., in ·1 c.c. tubes.

10th March.—Atypical.

22nd March.—Nil.

31st May.—Crude Sewage,	·01 c.c., clot, &c.,	typical =	100 per c.c.
,, Sedimented Sewage,	·1 c.c.,	typical =	10 ,,
,, Effluent I.,	·1 c.c.	typical =	10 ,,
,, Effluent II.,	·1 c.c. and ·01 c.c.	typical =	100 ,,
7th June.—Crude Sewage	·1 c.c. and ·01 c.c.	typical =	100 per c.c.
,, Sedimented Sewage	·1 c.c. and ·01 c.c.	typical =	100 ,,
,, Effluent I.	·1 c.c. and ·01 c.c.	typical =	100 ,,
,, Effluent II.	·1 c.c.	typical =	10 ,,

It is of great interest that these bacteria of definite intestinal origin—viz.: b. coli communis and b. enteritidis sporogenes—should have increased so markedly at the beginning of June. It was unfortunately impossible to follow up the investigation of this increase. During April and the first half of May no samples were taken. It is curious, however, to note that about the period of this increase (June) an epidemic of typhoid fever had broken out in Belfast. It seems highly probable that a continuous record of the occurrence of these two kinds of bacilli in the sewage would be of service in working out the origin of typhoid epidemics in Belfast. Generally speaking, the interest in investigating the occurrence of these microbes in sewage effluents is their connection with intestinal disease. The question has been carefully kept in view in other investigations as to whether the destructive action of the contact beds tells on these pathogenic forms more or less than on ordinary forms. These results are too negative to form the basis for a conclusion in regard to this problem. It is naturally a matter of minor importance in the case of Belfast compared to that of towns where the effluent passes into a river whose waters may be subsequently used for drinking. The question, however, does arise in connection with edible shellfish. Since Klein discovered the typhoid bacillus in the alimentary canal of an oyster it has been regarded as a matter of the greatest importance to prevent the introduction of shellfish into the market from beds situated in water polluted with sewage. It will, doubtless, be found necessary by the sanitary authorities to ascertain how far the cockle beds in the Lough, from which large supplies are drawn, are beyond suspicion in this matter.

OBSERVATIONS ON THE BACTERIAL GROWTH IN A MIXTURE OF SEA WATER AND SEWAGE.

The sea water used in these experiments was taken from the area of the "slob land." The sewage was diluted with this 250 times. The results give some idea of the rate at which bacteria are reduced in number in a mixture similar to an average sample of the sewage-charged water of the Lough. After a period lasting from a week to a fortnight the bacteria become greatly reduced in numbers. The cause of this I have not had the opportunity of working out.

TABLE No. IX.

First Experiment started 8th January.

——	Crude Sewage.	Screened and Sedimented.	Effluent from Upper Bed.	Effluent from Lower Bed.
10 January - - - -	—	150,000	75,000	87,500
12 ,, - - -	—	125,000	58,000	58,000
13 ,, - -	—	25,750	16,250	spoilt.
16 ,, - - - -	—	8,250	7,500	6,750
18 ,, - - - -	—	1,250	1,750	1,925

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TABLE No. IX.—*continued.*

Second Experiment started on 23rd March.

—	Crude Sewage.	Screened and Sedimented.	Effluent from Upper Bed.	Effluent from Lower Bed.
—	150,000	450,000	190,000	125,000
28 March - - -	26,300	43,200	15,700	17,500
1 April - - -	1,700,000	800,000	600,000	100,000
8 „ - - -	out.	out.	out.	out.

Third Experiment started 1st June.

1 June - - -	2,300,000	5,000,000	3,300,000	3,500,000
3 „ - - -	3,000,000	4,500,000	4,000,000	4,000,000
11 „ - - -	out.	out.	out.	out.

Fourth Experiment on 8th June.

9 June - - -	250,000	100,000	100,000	75,000
11 „ - - -	310,000	10,000	160,000	50,000
13 „ - - -	15,000	7,500	15,000	12,500
15 „ - - -	10,000	12,500	40,000	75,000
17 „ - - -	under 10,000	7,500	2,500	2,500
19 „ - - -	1,250	250	nil.	500

SUMMARY AND CONCLUSIONS.

The facts which have been established, even at the present incomplete stage of the investigation, yield some conclusions which are of value for the guidance of the Committee in their effort to obtain a satisfactory system of sewage purification. I have attempted throughout the report to compare the results I have obtained with those of other bacteriologists, and to correlate the chemical with the biological account of the "contact" process. The value of a large number of investigations on this subject, undertaken elsewhere, has been minimised by the fact that they did not include both chemical and biological observations. This is the more unfortunate as the major part of our knowledge of the working of "contact" beds is as yet experimental.

The first important consideration is to note the difference in the type of action which may be observed in the contact process according to different conditions. Every form of bed which is working efficiently causes a great transformation in the putrescible matter of the sewage, clearing away this substance to the extent of 80—90 per cent. of the whole. The nitrogen which enters into the composition of the putrescible matter is the constituent whose fate is carefully traced in the chemical study of the process. This nitrogen may appear in the effluent as ammonia, or as nitrites and nitrates, and, according to the analysis published, this, in certain instances, happens to a large extent, as, for example, in the case of the Manchester sewage beds. When we consider that in these substances (nitrates, etc.), the nitrogen is in the form most suitable for plant food, it is obvious that the effect of this kind of purification would be of no avail in diminishing the growth of the seaweed ("ulva latissima") whose decomposition on the foreshore causes a nuisance proportionate in magnitude to the amount of weed left to decompose. While in other respects the purification might be of a most excellent character, it would, in so far as it furnished these inorganic forms of nitrogen in the Lough, aid rather than diminish the growth of the weed. It is always to be remembered that we in Belfast have a problem of a very different kind from that before the Public Health Committees of many large towns, where these peculiar conditions caused by the existence of a great stretch of "slob land" do not occur.

The conversion of nitrogen into the forms of nitrate, etc., is generally believed to be due to the action of bacteria of a special kind, which require plentiful supplies of oxygen.

There is a second bacterial possibility of a somewhat similar nature. Bacteria have been described which possess the power of dispersing nitrogen from solution, in the form of gas. This would escape into the atmosphere as free nitrogen. I have in my report described a series of experiments in which I inoculated meat broth with the bacteria of sewage, and found a certain dispersion of nitrogen which I could not account for on any other supposition, and Professor Letts's study of the dissolved gases in the samples of sewage has led him to the conclusion that a considerable proportion of the nitrogen in the sewage disappears in this fashion. Should this dispersion of nitrogen depend, as we suppose, on the growth of particular species of microbes, a great deal might probably be done to further it.

These, as far as I know, are the only possible forms of a purely bacterial theory of "contact" action. The one mode of action is of no value for the problem before the Belfast Committee. The other is a perfectly satisfactory mode of action, inasmuch as it transforms nitrogen from a harmful to a harmless condition. Professor Letts has shown that, in the case of the brick beds, 12—20 per cent. of the nitrogen which disappears in the purification of the sewage can be recovered as free nitrogen in solution in the effluents. This change further seems to occur in the absence of the bacterial action which leads to the formation of nitrates and nitrites. The chemical analyses of the effluents from the brick beds show that, of the nitrogen which disappears from the putrescible form present in the raw sewage, practically none whatever reappears in the effluent as nitrate or nitrite. There is, therefore, in these beds

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a constant process of a very different type from that at work in the beds of the Manchester sewage system.

Leaving this point aside for the present, we have to ask the following question—"If by this mode of action only 20 per cent. (to take the highest value) of the nitrogen disappearing from the putrescible form can be accounted for, what becomes of the remaining 80 per cent.?" It has vanished without leaving any traces of a chemical kind. To explain this most important aspect of the case, I have studied the other biological factors which might come into play. I have found that connected with the sediment-covered bricks in the lower layer of the beds, there is a most potent agency for abstracting nitrogen from solution in dilute meat broth. When the sediment is examined microscopically, it is found to consist of a variety of animal forms. In the appearance of the various animal forms in a decomposing organic fluid a certain cyclical order is preserved, and one form is succeeded by another; the later forms causing a more or less complete extermination of those appearing earlier in the series. The actual presence in the sediment of the forms which are known to take part in such a cycle can be demonstrated by the microscope. The question as to how great a share in the process of purification this cyclical change has, I have not been able to determine, and I need not say that only the great demand for haste on the part of the Committee induced me to intermit the investigation before I was able to answer this most important question. We have, however, some evidence to go upon. In this cycle of living forms, bacteria have an early place, owing, no doubt, to their power of rapid growth, and their turn to be exterminated comes correspondingly early also. In the contact beds a great process of extermination takes place, as is shown in the table of total bacteria per c.c. of sewage and effluent. That this extermination is on a large scale may be inferred not only from the observed reduction in numbers, but also conversely from the overwhelming increase in numbers which appears in all the samples if they are kept in conditions favourable for bacterial growth. The effluent then represents the typical organic fluid at the point in the cycle of events when the bacterial forms are being exterminated. It is easy on this hypothesis to understand why the ratio of extermination of the bacteria should be in direct relation to the percentage of purification. The bacteria, we may suppose, have absorbed into their bodies the greater proportion of the nitrogen available for food. They become in turn the food of infusorians which live in and form the sediment on the bricks, and so the change in forms of life proceeds. The cycle reached its final stage so ar as I was able to observe with the introduction of worms (oligochaeta). These would ultimately pass out to the Lough and become the food of fishes. The nitrogen by this indirect means passes away from the beds in the form of animal tissue. All the nitrogen which can be diverted to this end vanishes from solution, and the sewage is purified in proportion. To strike the cycle and measure the magnitude of one of its events is to measure the general capacity of this living economy for dealing with the available food nitrogen at any given stages, or indeed at all stages of its existence. It is to measure the quantity of nitrogen which has been diverted into the forms of animal life. To measure the ratio of extermination of bacteria, therefore, is to measure the percentage of purification. Hence the correspondence between the two ratios.

We are, however, merely on the threshold of the investigation, and it avails nothing to go beyond the most obvious inferences.

To return to the practical problem, it is clear that the beds we have been experimenting with are the only known biological type which is suitable for Belfast. The percentage purification, according to all tests, chemical and biological, is a good deal lower than we have reason to expect, and it would be necessary to take steps to secure better results in practice than we have had. The size of the material of which the beds are composed and the nature of it, the depth of the beds, the length of the period of contact and period of rest, etc., should all be carefully investigated to discover how we may obtain the maximum purification. It would be very desirable, if not necessary, to raise the percentage purification to over 80 per cent., and, if possible, to over 90 per cent., and until this has been fully tested the Committee should not, in my opinion, involve themselves in too large an undertaking. It will be further necessary to pay the strictest attention to the working of the beds. The chemical and biological investigation of the combination of coke and brick beds was enough to show that their efficiency was considerably below that of the two brick beds.

There has been discussed an addition to the beds, which might assist in the process of purification, and there are, to my mind, some very clear grounds for considering it as likely to be of substantial benefit. It is that the effluent should be allowed to flow into a pond of sea water in which a crop of "ulva latissima" and possibly other seaweeds could be grown. Two advantages would accrue, in my opinion: (1) The weed during the season of growth would absorb the ammonia which had not been dispersed in the beds, and thereby raise the percentage of purification. (2) The particulate matter in suspension in the effluent has, when allowed to stand a strong tendency to form a tough sediment. This, if it occurred in the proposed intercepting pond, would also increase the percentage of purification in the effluent before it reached the Lough. The weed would be available only in summer, but it is then that the foreshore nuisance is chiefly felt.

One other practical question requires mention. For the successful working of the scheme all other sources of organic nitrogen by which the Lough water may be enriched should be curtailed as far as possible. A certain amount of nitrate must be continually brought down by the land drainage in the Lagan area, and there seems no possibility of preventing this. On the other hand, the sewage and other discharges containing organic matter from the houses and villages round the side of the Lough should be prevented from reaching the water in a form suitable for acting as a manure to the weed. Further, the present and subsequent crops of the weed should be removed until the store of nitrogen already in the Lough becomes exhausted. If the present growth of weed is allowed to decompose, and pass back into the water, it will be available as manure to the subsequent crops.

In view of the facts which I have described in the report, I am convinced that the Committee is justified in proceeding in an experimental manner towards the establishment of a scheme of sewage purification similar in type to that exemplified in the present brick beds.

I cannot close this report without acknowledging the help which I had in carrying out the work from various members of my laboratory, and in particular from Dr. Moorhead Beatty. Without his untiring assistance I should have been quite unable to undertake many of the most important lines of investigation.

J. Lorrain Smith.

Queen's College, Belfast, August, 1901.

APPENDIX II. TO Dr. LORRAIN SMITH'S EVIDENCE.

Report on the Bacteria found in Shell-fish obtained from Belfast Lough on April 7th, 1902.

The investigation of the bacteria in the sample of shell-fish obtained in the Belfast Lough, which I have now to describe, was undertaken with a view to determine whether the consumption of shell-fish from the same source involved in any recognisable way the danger of infection by the typhoid bacillus.

To provide an answer to such a question two methods of procedure may be adopted. The most natural and direct form of answer would be to show whether or not the typhoid bacillus is present in the shell contents. On the other hand, a more comprehensive method of investigating the problem would be to show whether or not the shell-fish contain bacteria, which are due to the presence of sewage in the surrounding water.

The latter method was employed in the present investigation. To find the typhoid bacillus anywhere except in immediate relation to the patient suffering from typhoid fever is a matter so surrounded with difficulty that to fail to do so, in any given instance where it would be expected to be present, leaves on the mind the impression that the difficulties of the search have been too great, rather than that the bacillus was absent. While, therefore, the second method was employed, it is only fair to add that in carrying out the details of it every attempt was made to discover the typhoid bacillus, and this was all the more effectively done because in both cases the forms of procedure are in essential respects identical.

Amongst the microbes which are found in sewage, more or less constantly, three forms have been regarded by

recent investigators as of special significance. These differ widely from each other, and each one of them has special importance. In the first place, as a sign of recent contamination with sewage, stands the streptococcus. This microbe occurs plentifully in human faeces, while it is very rarely, if ever, found in water or in soil which has not been recently contaminated with sewage. Associated with it is the staphylococcus, which is, however, of slightly less significance, because, being a hardier form, it is capable of surviving where the more delicate streptococcus disappears. The presence of the more delicate microbe is regarded, therefore, as indicative of a more recent contamination with sewage. In the next place, the bacillus coli communis is of significance because of its close similarity to the typhoid bacillus, and its constant association with it whenever it occurs. This microbe, though it is so closely allied to the typhoid bacillus, and in some of its forms is hardly distinguishable from it by any known methods, is an inhabitant of the healthy intestine. It is possessed of much greater vigour than the typhoid bacillus, and this in a measure explains the frequency of its occurrence. Its power of survival is seen from its frequent presence in water and sewage; but it fails in the struggle with the microbes resident in the soil, and is rarely found there. Lastly, the bacillus enteritidis sporogenes of Klein is of interest, because, as compared with the two former microbes, it has the greatly increased power of survival which belongs to the spore-bearing microbes, of which it is an example. It is also a natural inhabitant of the intestine, and grows only under anaërobic conditions. It is unnecessary here to explain the relation of these microbes to disease. Each of them possesses definite power of producing disease; but we are here concerned rather with their presence as evidence of sewage contamination

The methods employed in examining the shell-fish were:—

(1) The shell was carefully brushed in sterile water with a sterile nail-brush. The shell was then opened with a sterile pair of scissors. The fluid part of the shell contents was then pipetted of, and cultivation plates with phenolated agar were made with different quantities of this water.

Four fish were investigated in this way. Since the medium used was one specially suited to the growth of b. typhi and b. coli communis, we cannot form any conclusion as to the total numbers of the bacteria present. Many ordinary forms are unable to grow in the presence of small quantities of carbolic acid.

In the fluid of cockle 1 by this method there were isolated only micrococci many of them streptococci.

In the fluid of mussel 1, again streptococci were found.

From the fluid of cockle 2 nothing grew in this medium.

From the fluid of clam 2 streptococci only grew.

The result of this series of observations, full details of which are given at the end of the report, is that the presence of streptococcus was demonstrated in three out of four shell-fish examined by this method.

(2) The second method employed was to inoculate a guinea pig with this fluid.

Clam 3. A guinea pig was inoculated with 1 c.c. of the fluid by a subcutaneous injection. In forty-eight hours the guinea pig was dead, and great œdema had developed. From the fluid which had gathered in the tissues a pure culture of b. coli communis was isolated. This bacillus had evidently a fairly high degree of pathogenic power.

(3) In the third place, cultivation of the microbes which are contained inside the shell was carried out in phenaloted broth; and from the flasks plates were made, and the kind of micro-organisms growing then studied. This method again was adapted to the isolation of b. coli and b. typhi.

From mussel 3 varieties of b. coli communis were isolated.

From scallop 3 a similar result was obtained.

From cockle 3 a similar result was obtained. It is to be observed that in some points the form of b. coli were atypical. For example, many of them failed to form indol, even in peptone water, after more than a fortnight. Other forms, however, gave the indol reaction. In all these three cases there was evidence of the presence of the coli bacillus. To this is to be added the evidence obtained by the inoculation experiment.

(4) The fourth method was that of the heated milk tubes. From this, evidence of the presence of the spores of the b. enteritidis sporogenes of Klein in the body fluid was investigated with the following result:—

(1) Mussel 4 Spores present: less than 100 per c.c.

(2) Scallop 4 Spores present: less than 10 per c.c.

(3) Cockle 4 Spores present: less than 100 per c.c.

(4) Whelk 1 Spore present: at least 10 per c.c.

(5) Whelk 2. No spore in 1-10 of 1 c.c.

(6) Whelk 3 Spores present: at least 10 per c.c.

The result is, that, in five out of six, the evidence of this test was positive as to the presence of b. enteritidis sporogenes of Klein.

I have, for the sake of comparison, given the details of observations on cockles obtained from sea water, which is free from the suspicion of sewage contamination. The result of these observations is to show (1) The absence of streptococci in the four specimens examined. (2) The absence of the spores of b. enteritidis sporgenes in four cockles examined. (3) The absence of b. coli communis in the three flasks in which cultivation of the bacteria attached to the gills of the fish had taken place.

These observations, both the former ones on the shell-fish from contaminated water, as well as the latter on those from clean sea water, could be multiplied indefinitely. As regards the latter series of observations, however, the results, so far as they are on the same lines as those of Professor Klein on oysters, are in agreement with his (On Oyster Culture in relation to Disease, Local Govt. Report, Supp. 1894-95, p. 109).

There is therefore less necessity to extend that series of observations. As regards the question of contamination in the Lough, a prolonged series of observations of shell-fish from different situations would give us correspondingly reliable indications of the extent to which the impurities of the sewage have spread. In the meantime, however, a very much narrower problem was before me, viz.—whether the consumption of shell-fish from the same source as that from which the specimens came might be regarded as the cause of typhoid fever. It is clear from the results that these shell-fish are the vehicle of microbes which are regarded as signs of recent sewage contamination. It is also clear that these microbes may exist in the shell-fish with a fairly high degree of virulence.

How far are we justified in regarding shell-fish contaminated with sewage as a source of typhoid fever? The discussion of this question has taken place to a large extent in connection with the regulation of the oyster trade. In the Local Government Report already referred to, on oyster culture in relation to disease, Sir Richard Thorne Thorne includes detailed descriptions of specific instances when typhoid infection had been traced to the consumption of oysters which had been exposed to contamination with sewage. He also quotes the conclusion of the report of a Special Commission of the French Academy of Medicine, which is that "the consumption of oysters which have been kept in polluted water may cause gastro-intestinal disturbances, and even typhoid fever." He points out further, that "when other molluscs than oysters are used for human consumption in much the same way as oysters are, that which applies to oyster culture applies to them also" (p. XXVI.). Sir Richard Thorne Thorne deals also with the question of the rarity of the infection by means of oysters. His argument may help to explain a difficulty which would naturally occur to the minds of those considering the opportunity for pollution in the Lough. Since we must believe that shellfish can be vehicles of the harmful microbes of sewage, how are they so often eaten without evil effect? The same problem had arisen in relation to cholera infection by polluted shell fish. He says: "In order to enable a given sample of oysters to convey the infection of any specific disease, it would be necessary that the shell cavity, or body of the mollusc, should retain some portion of the sewage—often in a state of great dilution—to which it had been exposed; that this specific infection should not be destroyed by antecedent cooking or otherwise; and that

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the oyster or oysters should be consumed by some susceptible person." Another conclusion, in support of which all the observations seem to agree, is that the bodies of the shell fish, or the water inside the shell, while they may contain these microbes from sewage, are not favourable media for their growth. They may survive, but apparently do not multiply in these situations. The dose, therefore, which reaches the consumer must in nearly every case be a small one, and possibly in many instances too small to have any harmful effect. On these grounds also we may explain why a source of infection such as this should be so seldom operative.

Finally, it may be well to restate the conclusion which we have now before us.

The shell fish examined showed in their shell contents certain microbe of widely different kinds; each form, however, being a natual inhabitant of sewage.

In the inoculation test carried out, one of these forms was found to be possessed of a moderately high degree of virulence. This observation leads us to infer that the specific microbe of typhoid fever also might be conveyed to the consumer in an actively infective condition.

The risk to the consumer is therefore real; but there are reasons why this mode of infection is frequently inoperative. The risk would become greater as the sewage is more richly supplied with typhoid bacilli, as, for instance, in an epidemic of typhoid fever. With endemic typhoid the risk must be a constant one.

The danger to the consumer from the non-typhoid microbes, the presence of which is describer in this report, is probably twofold. They may cause intestinal inflammation, or they may increase the susceptibility of the patient to the typhoid virus by causing some intestinal disturbance. Considerations on this point cannot, however, in the present state of our knowledge, be advanced in any form of certainty.

J. Lorrain Smith.

Pathological Department, Queen's College, Belfast,
July 9th, 1902.

SHELLFISH OBTAINED FROM BELFAST LOUGH.

Cockle I.—Opened and fluid pipetted from interior and planted on phenolated agar plates on April 8th. Fluid showed multitudes of bacteria to the microscope.

—	Plate I.	Plate II.	Plate III.	Plate IV.	Plate V.	Plate VI.	Plate VII.	Plate VIII.
8 April	1/10 c.c. fluid -	1/10 c.c. fluid	1 loopful	1 loopful	1/50 c.c. fluid -	1/500 c.c. fluid	1 loopful of dilution, 1 in 50.	1 loopful of dilution, 1 in 50.
10 April -	Colonies not very numerous, coli-like, 12 planted on gelatine.	About 100 colonies, 12 coli-like planted on sloped gelatine.	Sterile -	4 colonies, 3 planted on sloped gelatine.	About 18 colonies, 11 coli-like, planted on sloped gelatine.	Sterile -	Sterile -	Sterile.
15 April -	15 coli or typhoid-like colonies from I., II. and IV. plates transferred to glucose agar. None gave gas bubbles or exuberant growth.	—	—	—	April 21st.—Six typhoid - like colonies planted on glucose agar. All these were streptococci.	—	—	
22 April -	Added broth to all these; after five hours only two were turbid. They were all cocci, many of them in the form of diplococci.	—	—	—	May 2nd.—Planted in milk. Milk coagulated in a week. The cocci stained by Grams method.	—	—	

Mussel I.—Fluid obtained from the interior of the shell and planted out in phenolated agar. 1-10 c.c. fluid added to 5 c.c. sterile water. From this plates were made as follows:—

——	Plate IX.	Plate X.	Plate XI.	Plate XII.	Plate XIII.
8 April - -	1/10 c.c. of dilution -	1/10 c.c. of dilution -	1/10 c.c. of dilution -	One loopful of dilution.	One loopful of dilution.
10 April - -	Five colonies, three planted on sloped gelatine.	Two colonies, one planted on sloped gelatine.	Two colonies, one planted on sloped gelatine.	Sterile - -	Sterile.
21 April - -	Examined and found streptococci.	Examined and found streptococci.	Examined and found streptococci.	—	—

COCKLE II.—1-10 c.c. of body fluid added to 5 c.c. of broth. Fluid full of microbes.

—	PLATE XIV.	PLATE XV.	PLATE XVI.	PLATE XVII.	PLATE XVIII.
8 April	1 c.c. of the dilution.	$\frac{1}{10}$ c.c. of the dilution.	$\frac{1}{10}$ c.c. of the dilution.	One loopful	One loopful.
10 April	0	0	0	0	0

CLAM II.—Fluid obtained and planted out as before.

—	PLATE XXII.	PLATE XXIII.	PLATE XXIV.
8 April	One c.c.	One c.c.	One loopful.
10 April	About 20 colonies, planted six on sloped gelatine.	About 20 colonies, planted five on sloped gelatine.	0
21 April	All streptococci	All streptococci	—

April 8th.—CLAM III.—1 c.c. of the fluid inoculated into guinea pig subcutaneously. Guinea pig dead in 48 hours with very extensive œdema. The œdematus fluid showed plentiful bacilli. These were planted out aërobically and anaërobically, and typical growth of b. coli communis was obtained in pure culture.

SCALLOP III.—Part of the gills removed with sterile scissors, and placed in flask containing diluted phenolated broth, on April 8th. After 18 hours broth was uniformly turbid. Seven plates made with phenolated agar.

April 12th—18 colonies planted out on sloped gelatine.

April 26th—12 coli-like. One of them was planted out, and gave the following results:—Agar, coli-like growth; glucose agar, gas bubbles; milk coagulation in 24 hours; broth, uniform turbidity. No indol on May 1st. Potato yellow growth. Microscopically the bacillus had the coli characters.

May 1st—Planted 1, 2, and 3 in peptone water, and incubated them at 37° C. till May 17th. They were then tested for indol, but gave negative results.

COCKLE III.—Part of the gills was removed with sterile scissors, and placed in flask containing diluted phenolated broth. After 18 hours the broth was uniformly turbid, and seven plates were made from it with phenolated agar on April 9th.

April 12th—After 48 hours the plates all contained discrete colonies. The superficial ones had the appearance of coli growth. Twenty-two colonies were planted on sloped gelatine.

April 21st—Six of the most typical colonies were planted on glucose agar.

April 26th—All these were coli-like. One of them was planted out, and gave the following results:—Potato yellow growth; milk coagulation in two days; broth, no indol in five days. Microscopically the appearance of b. coli.

May 1st—Nos. 2, 3, and 4 planted in peptone water. No indol on May 17th.

MUSSEL III.—Part of the gills removed with sterile scissors, and placed in flask containing diluted broth (phenolated), on April 8th.

April 10th—12 plates made with phenolated agar from broth which had become uniformly turbid.

April 12th—Planted 22 colonies on sloped gelatine.

April 21st—Planted the suspicious growths in gelatine on potato, and on glucose agar.

April 26th—Five of these were coli-like after growing on potato and glucose agar.

One of them gave the following tests:—Characteristic coli appearance on sloped agar; gas bubbles in glucose agar; broth uniformly turbid; indol reaction; milk coagulated in two days; a yellow growth on potato; microscopically like coli bacillus.

Four others planted out. Milk coagulated in two days; broth uniformly turbid; agar, characteristic growth; gas bubbles in glucose agar; yellow growth on potato; indol present in one, absent in three.

On May 31st three colonies like coli were planted in peptone water; examined on May 17th for indol; absent in all.

In this case there were present typical and atypical forms of b. coli communis.

MUSSEL IV.—Opened with antiseptic precautions. The fluid was taken to test for the presence of B. enteritidis sporogenes of Klein. The fluid was added to milk in varying proportions, and the tube was then heated to 80° C. for 10 minutes. After this, it was incubated in an atmosphere of coal gas, which was exposed to a strong solution of pyrogallate of potash, and examined after 40 hours. The bacillus enteritidis sporogenes is one of the natural bacterial inhabitants of the intestinal tract. The fact that this microbe naturally assumes the resistant spore form enables it to survive in conditions which would prove fatal to either the streptococcus or the B. coli communis. The change which takes place in the milk is the rapid formation of a ragged coagulum, which stretches through the tube, and which is surrounded by a clear whey. In the whey, gas bubbles are found entangled by the coagulum.

The body fluid was added to milk tubes in various proportions, and gave the following results:—

I. $\frac{1}{4}$ c.c. gave typical reaction in 40 hours.
1-10 c.c. ,, ,,
1-100 c.c. Nil.
1-1000 c.c. Nil.

In the body fluid there were therefore less than 100 spores of this bacillus per 1 c.c.

SCALLOP IV.—Opened aseptically, and body fluid taken to test for the presence of B. enteritidis sporogenes.

I.—1 c.c. fluid gave typical reaction in 40 hours.
II.—1-10 c.c. fluid, nil.
III.—1-100 c.c. fluid, nil.
IV.—1-1000 c.c. fluid, nil.

In the body fluid, therefore, there were less than 10 spores of this bacillus per 1 c.c.

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COCKLE IV.—Opened aseptically, and body fluid taken to test for the presence of B. enteritidis sporogenes.

I.—1 c.c. fluid gave typical reaction in 40 hours.

II.—1-10 c.c. fluid „ „ „

III.—1-100 c.c. fluid, nil.

IV.—1-1000 c.c. fluid, nil.

WHELK I.—Treated as before to test for presence of C. enteritidis sporogenes.

I.—1-10 c.c. fluid, nil in 40 hours.

WHELK II.

I.—1-10 c.c. fluid, nil in 40 hours.

WHELK III.

I.—1-10 c.c. fluid. Typical in 40 hours.

COCKLES OBTAINED FROM A SOURCE WHICH WAS FREE FROM SEWAGE CONTAMINATION.

COCKLE I.—From the body fluid plates were made with phenolated Agar.

	PLATE I.	PLATE II.	PLATE III.
14 May - - -	·5 c.c. of fluid.	$\frac{1}{10}$ c.c. of fluid	$\frac{1}{100}$ c.c. fluid.
17 May - - -	Numerous colonies.	50 colonies. 10 planted out in gelatine.	Nil.

These colonies were uniformly a sarcina which did not liquefy gelatine nor coagulate milk, but stained by Gram.

COCKLE II.—Fluid from body planted out in phenolated Agar.

	PLATE IV.	PLATE V.	PLATE VI.
14 May - - -	1 c.c.	$\frac{1}{10}$ c.c.	$\frac{1}{100}$ c.c.
17 May - - -	Numerous colonies.	15 colonies. Planted out in gelatine.	Nil.

Colonies were a form of Sarcina.

COCKLE III.—Fluid planted out in phenolated Agar.

	PLATE VII.	PLATE VIII.	PLATE IX.
14 May - - -	1 c.c.	$\frac{1}{10}$ c.c.	$\frac{1}{100}$ c.c.
17 May - - -	Numerous colonies.	12 colonies. 8 of them planted in gelatine.	Nil.

These were a form of Sarcina.

COCKLE IV.

	PLATE X.	PLATE XI	PLATE XII.
14 May - - -	1 c.c.	$\frac{1}{10}$ c.c	$\frac{1}{100}$ c.c.
17 May - - -	Numerous colonies.	30 colonies. 9 planted in gelatine.	Nil.

These colonies were a form of Sarcina.

FLASK I.—100 c.c. water; 1 c.c. of 5 per cent. carbolic acid and 12 c.c. broth.

COCKLE V.—Body of cockle added to flask.

In 40 hours there was a large scum of bacterial growth on the top; there was no turbidity. This flask was not further examined.

FLASK II.

COCKLE VI.—Body of cockle added to flask. Uniform turbidity in 40 hours. Planted out, and colonies planted on sloped gelatine, etc.

FLASK III.

COCKLE VIII.—Body of cockle added to flask.

Uniform turbidity in 40 hours.

Plates made and colonies planted out.

The colonis planted out from Flasks II. and III. resembled coli in some respects (milk, broth, gelatine). They differed, however, on potato, where they formed a glistening white growth, becoming golden yellow in a few days. They also formed a violet red pigment in glucose-agar.

Cockles tested for the presence of B. enteriditis sporogenes:—

COCKLE V.

Tube I.—1 c.c. fluid. No coagulation in 48 hours.

Tube II.—1-10 c.c. fluid. „ „

COCKLE VI.

Tube I.—1 c.c. fluid. Coagulum atypical in 48 hours.

Tube II.—1-10 c.c. fluid, nil.

COCKLE VII.

Tube I.—1 c.c. fluid, nil.
Tube II.—1-10 c.c. fluid, nil.

COCKLE VIII.

Tube I.—1 c.c. fluid, nil.
Tube II.—1-10 c.c. fluid, nil.

Mr. GEORGE GILES, called; and Examined.

Mr. G. Giles.

31 July 1902.

13675. (*Chairman.*) You are, I understand, a member of the Institute of Civil Engineers, and Chief Engineer to the Belfast Harbour Commissioners?—Yes, sir.

13676. I believe you wish to give evidence in regard to the sewage disposal of Belfast?—It was more in connection with the discharge of the sewage into Belfast Lough. I am told that evidence was given this morning to say that it was not a nuisance to the Harbour Commissioners. Well, I will not go so far as to say that it is a nuisance to them, but it is the cause of a great expense to them. I can give you an instance. Three or four years ago we actually dredged from the Victoria Channel between 30,000 and 40,000 tons of what was crude sewage, fæcal matter, which was as black as ink, and the stench from which was something terrible. That accumulation was going on for years, and is still going on, and is due, no doubt, to the discharge of solids into Belfast Lough. When I say that the 30,000 or 40,000 tons were removed at a cost of something like 6d. per ton, you can arrive at some estimate of the cost to the Harbour Commissioners. The young flood washes it into the deep water of our channel. The sewage is discharged from one end of the Lough to the other almost, and the young flood sweeping up from the north brings a large quantity of the solids and deposits them in our channel. On the northern bank of the channel the sewage lies in very large quantities, on the western side of the channel there is a large accumulation of black filth, while on the eastern side there is none. That proves the truth of my observations.

13677. (*Chairman.*) How far were the dredging operations from the outfall?—About half a mile.

13678. Have you noticed any increase as compared with the condition of things before?—Previous to the opening of this outfall there was no deposit in the channel. It was all deposited inside the Harbour. Of course, the conditions were very much worse then, and the dredging was then all sewage matter.

13679. Then all the dredging does not reveal this black matter?—Not at all. A few years ago we deepened our channel by 3ft., and in the course of those operations we came upon this black sewage all lying upon the old level of the channel. Some ten years ago we were dredging outside the Twin Islands, and we met with no sewage matter at all; it was simply ordinary sludge.

13680. You would see with satisfaction the adoption of a system which would withdraw the suspended solids from the sewage?—Yes. The Harbour Commissioners are anxious that the Corporation should undertake it at the earliest possible moment. The opposition of the Harbour Commissioners was withdrawn from the Act of 1899 on the understanding that the Corporation would immediately proceed to purify the sewage of Belfast, and would complete a system of sewage purification within three years; the time is up, and you know how much they have done.

13681. This black deposit involves a considerable expense to your Board, that is all you say. You do not state that it is a nuisance to your Board?—Yes, that is all I say, it involves considerable expense. It is only a nuisance to the unfortunate men who have to remove it.

13682. Are you able to estimate the cost of the removal of this black deposit?—No, it is hardly possible to do so.

13683. It would interest us to know if it could be directly traced to the presence of the sewage. Is it not possible that some part of it may be due to other causes?—I think not, sir, from the condition of the dredged material. We carry out very large dredging operations here, and we know from them the material with which we have to deal and where we may expect to find it. We always expect to find sewage in this particular place, and we do find it there.

13684. It would not be difficult to have samples of this deposit examined to find out how far it is intestinal discharge?—It could very easily have been done.

(*The witness here produced a chart, which was explained to the members of the Commission.*)

13685. (*Dr. Russell.*) You dredge the channel out every four or five years?—Yes, that is so.

13686. You have the necessity to dredge it out oftener than before?—No, we have widened it.

13687. It is obvious from the character of what you dredge now that there has been a change in quality, but that does not mean it has increased in quantity?—This outfall has only been used since 1893, and as we have only dredged this channel once since then I cannot say.

13688. There is a considerable leakage from the outfall?—Yes, it leaks all the way.

13689. Who are the owners of the Harbour Estate we heard about this morning?—The limit of our jurisdiction is from Carrickfergus to Grey Point.

13690. Are the Harbour Commissioners the owners of the Harbour Estate?—Yes, they are the owners in trust.

13691. Are they responsible for the discharge of this crude sewage into the Lough?—No, sir, the Corporation are responsible for that.

13692. Because it was said here that the sewage from the Harbour Estate including fæcal matter produced in consequence of the employment of thousands of workmen and others employed in the shipping industry, is still discharged into the river. Who is responsible for discharging it; the Harbour Commissioners have got no sewers?—There are drains from the Estate, and if anybody discharges sewage it is done surreptitiously.

13693. (*Chairman.*) But a large number of men are employed on the Estate?—Yes, but they should use nothing but earth closets. On the County Antrim side they use nothing but earth closets, but on the County Down side I am afraid the Commissioners are defied in this matter.

13694. Is not the discharge of that sewage close to the channel?—No, it is far away from it.

13695. Therefore, the deposit cannot be due to that?—No.

13696. (*Dr. Stafford.*) But there would be a considerable amount of sewage if there were thousands of workmen employed there?—There is, no doubt.

13697. But the sewage must be got rid of, and the only way to get rid of it is by carrying it out to the Lough?—Under present conditions that is so, but our argument is, they should not do so now; they have done practically nothing all this time except experimentalise.

13698. Can they take you into their system?—Yes, they are bound to do so.

13699. But they have not yet?—No.

13700. And to a large extent you have done nothing?—The Commissioners do not see the object of spending a large sum of money for taking the sewage to that part of the Estate for the Corporation to dump it down again into their channel.

13701. You do not think it unreasonable that the Corporation should have a certain amount of time in which to investigate this matter before they commit themselves?—We think that reasonable enough, but the Corporation did not begin their experiments until about a year ago.

13702. You are satisfied now with the rapidity of their progress?—No, I would like to see them going ahead a bit quicker.

13703. Scientifically or otherwise?—Well, scientifically, but I hear in regard to Professor Letts' report, 11 months have been wasted.

13704. (*Chairman.*) It does not appear that any nuisance arises from the discharge of the sea water beyond the promotion of the growth of the weed the ulva, part of the debris of which rots on the shore, and so causes a nuisance?—That is a great nuisance.

13705. Would it be necessary, do you think, for the Corporation to undertake any great expense; what is the cost of one dredging of this channel?—That would cost about £2,500.

13706. Then you suggest that the cost to the Board is about £500 a year?—I don't think I would like to say that, I think it is an extreme amount. It is very difficult to estimate the yearly amount.

13707. No nuisance arises from it, merely the extra cost of dredging?—I think we may say that, sir. May I say that my theory as to the growth of the ulva latissima on the south shore is that the banks on the south are mainly composed of sand, and it seems to me that this

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sea lettuce thrives better on the sand banks than on the mud. On the northern side it is mainly soft mud, and I don't think it grows so readily there as on the sand.

13708. (*Chairman.*) There was some remark about the cartage of this decaying ulva from the shore; what have you to say about that suggestion?—I do not think it would meet the difficulty at all. Last year there was a tremendous deposit of the ulva at Cultra. I made a rough estimate of the material which was rotting there, and it amounted to about 14,000 loads in one little bay about 1,000 feet long. That could not be carted away under 1s. per ton, and there is £700, and after one tide there might be almost as much again.

13709. Was that an accumulation of a very long time?—It might be the accumulation of a few weeks.

13710. Does a violent storm disperse it?—Yes, it sometimes does so on the County Down side.

13711. In your opinion, the removal by carts would be too costly?—It would be better to adopt a system of sewage purification so as not to promote the growth; the removal only touches the fringe of the question; it is just a pin-prick. On that coast there is such an enormous quantity of it, if they got all the carts in County Down and in County Antrim, they could not remove it.

13712. But it is only necessary to remove the decaying ulva?—But it will soon be thrown back upon the shore.

13713. In what sense is it only touching the fringe of the subject?—Because they cannot remove it quickly enough.

13714. (*Dr. Stafford.*) There is only a short period of the day in which carts could work?—Yes, about six hours per day. I don't think the removal is at all practicable because of the large extent of it.

(*Chairman.*) Well, it is a valuable point for inquiry.

FORTY-SIXTH DAY.

Tuesday, October 14*th*, 1902.

PRESENT;

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P., *in the Chair.*

Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Mr. W. H. POWER, F.R.S.
Colonel T. W. HARDING, J.P.
Dr. JAMES BURN RUSSELL.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary.*

Mr. R. A. TATTON, M.I.C.E., re-called; and further Examined.

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13675*. (*Chairman.*) I think, Mr. Tatton, in reference to the relative rights of the manufacturers and local authorities, you have had put in your possession in the first place a list of the questions which we desired to put to them respectively?—I have, yes.

13676*. And I think you have also had placed before you the evidence which we have received from various manufacturers and various local authorities?—Yes.

13677*. What we wish you to do now, and what you are prepared to do is to give us your opinion upon the various questions which have been raised in the evidence given by those two classes?—Quite so.

13678*. You have sent in, have you not, some type-written statements?—Yes, I have.

13679*. Would you put those in as evidence or would you rather take those simply as a basis on which you will give us more complete and fuller statements?—I could put those in as evidence if you think that would be the most convenient course.

13680*. (*Colonel Harding.*) I certainly think so, these notes have evidently been carefully considered and represent the opinion of Mr. Tatton, who would only repeat himself?—Yes, that is so.

(1) I am of opinion that there are some points as to the rights of manufacturers and local authorities which are not clearly defined under the existing law—the most important of these are:—

Is a local authority bound to admit trade waste into the sewers? If so, we may conclude that there is also an obligation to make new sewers of sufficient size for the trade waste in addition to the domestic sewage, but this is a point about which there seems to be considerable uncertainty. Again, it seems uncertain whether an authority has power to exclude a manufacturer (already in the sewers) from them, although his trade waste may be the cause of great extra expense in treating the sewage; further if the authority has not power to turn out the manufacturer, has it power to make him carry out preliminary treatment?

Has an authority in any case power to compel a manufacturer, whether he is already in the sewers or only trying to gain admission, to carry our preliminary treatment?

If such questions as these could be definitely settled the work of the Rivers Boards would be considerably expedited.

Another point of uncertainty, which is, however, rather outside this particular inquiry, is the question as to responsibility for connecting domestic drains to the sewers. Local authorities frequently "leave the work to the property owners, and do not like to press them because they are doing it at their own expense." Other authorities do the work themselves under legal advice that they are the responsible parties.

(2) It is generally agreed that many manufacturers, especially in large towns, are unable, owing to want of space, to efficiently treat their trade waste and that the only means of preventing pollution of the streams is to admit the waste into the sewers. I think, therefore, that the manufacturer should have power, under restrictions, to get admitted, and I also think that the local authority should have power to put manufacturers already in the sewers under the same restrictions. This is not so under the existing law; manufacturers already in the sewers have a distinct advantage over those who are not, as it seems doubtful whether authorities have any control over the former unless a nuisance or some similar offence is caused by their waste, whereas whether legally or not, they do frequently insist on making terms with the latter before consenting to take them in. It is fair in the interests both of the manufacturers and the authorities that this should be so; the manufacturers should all be on the same basis as much as possible, and the authorities should have power to protect their interests. If the law were made clear that, firstly, manufacturers have a right to be admitted into the sewers, and, secondly, that authorities have a right to make bye-laws to protect their interests, a great deal of the present uncertainty would be removed and the respective parties would be more likely to come to terms.

(3 and 4) The safeguards required should secure firstly, with regard to the sewers, that no damage

should be done to them or interference caused with the free flow of the sewage, that no refuse should be turned into the sewer which may by itself or in combination cause explosions or cause a nuisance, or do harm to the workmen engaged in the sewer; they should secure secondly, with regard to the outfall works, that the treatment of the sewage should not be unduly interfered with either through the waste being turned in irregularly or through the waste containing anything which makes the sewage difficult and unreasonably expensive to treat.

The safeguards with regard to the sewers may be secured by the following means:—

Tanks must be provided in the works to intercept the grosser solids, which would be liable to settle out in the sewer and interfere with the flow of the sewage; these tanks must be sufficient to effect this purpose, and, if necessary, to equalise the flow (to be dealt with later), but they would not be required to effect purification to the same extent as in cases where the waste flows from them direct into the river. Their capacity should be governed to some extent by the dry weather rate of flow of the sewer into which they discharge, that is to say that if the sewer has a slight gradient only, and low velocity of discharge, the tanks must be larger than if the velocity of discharge of the sewer is a high one. Another point in connection with the size of tanks required must not be lost sight of. Trade waste, even when the suspended solids have been removed, is liable to cause precipitation of further solids when discharged into other waters although comparatively clear; still more so is this likely to happen in a sewer.

Although a total tank capacity equal to a whole working day's flow is no doubt desirable, it need not necessarily be essential; many works are so situated, especially in towns, that tanks of this capacity would be quite out of the question owing to want of space, and it is works in such situations which it is especially desirable should drain their waste into sewers, the alternative being either to close the works or pollute the stream. In such cases I think they should be required to use, in the words of the Rivers Pollution Prevention Act, the "*best practicable and available means*" to render their trade waste harmless, the question of what is the best available means to be determined by some Central Board as has been suggested, if the manufacturer and the local authority fail to come to terms.

Further, at works where a large volume of water, say from 50,000 to 500,000 gallons per day is used, a tank capacity equal to a day's flow will not be required; it is the concentrated portion of the waste which causes the trouble at the outfall works.

In such cases the greater portion, probably 80 or 90 per cent., of the waste is washing water, containing a comparatively small amount of suspended matter, and in the ordinary course of manufacture is discharged fairly regularly, and beyond increasing the volume of flow at the sewage outfall works, which is a contingency they must always be prepared for, it does not cause any great difficulty. What does cause difficulty is the waste from dyebecks, soapbecks, boiling kiers, etc., several of which may be run off within a short period. This kind of waste is very concentrated, and should certainly be held up in tanks in order that it may be delivered in regular quantities. To this must be added the wash water at works where it is small in volume, when it may be expected to be more foul, and possibly in some cases a portion of the wash waters from large works.

If these conditions are carried out, I do not think there are many works where tanks could not be put down sufficient to secure the local authority from damage.

The outlet to the tank must be of such a size as will ensure the discharge of a day's volume, if this is the amount agreed upon, being spread over a period of 12 hours, and if floating arms are used the tanks will act as settling tanks as well as regulating the flow.

At certain works chemical treatment in the tanks will be necessary; it has been proved to be so in the case of wool-scouring works, and experience may show that it is necessary in other cases also. At Rochdale, which is within the Mersey and Irwell watershed, wool-scouring waste has caused trouble and increased expense at the outfall works, and I think it only fair that the manufacturers should be prepared to treat it, as the cost to which they would be put in doing so would be a trifle compared to the cost which the waste if turned untreated into the sewers entails on the authority. This class of waste must be treated with acid, and the grease removed from it as much as possible before it is allowed to flow into the sewer.

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The waste pickle from galvanising works is another trade waste which causes trouble at outfall works if it is sent into the sewers unregulated, but if it is spread over the day it assists in the treatment of the sewage, being a good precipitant.

The sludge collected in the tanks will, with the exception of that from wool-scouring waste in most cases be valueless. It should be removed from the tanks by the manufacturer and carted away either by him or by the local authority according to arrangement; the latter is probably the best arrangement, and has been adopted by the Salford Corporation.

The sludge from wool-scouring waste, owing to the large amount of grease it contains, may be of value, and at the present time in the Rochdale district at many works the grease is recovered and the sludge removed by a contractor at no cost to the manufacturer.

(5.) As a rule manufacturers are prepared to adopt means for the removal of suspended solids, grease, etc., from their trade waste before discharging into the sewer. They fully recognise the fact that the time has come when they may be expected to treat their waste, and those in towns and within reach of sewers take a reasonable view of the matter.

(6.) Some tribunal to whom appeal could be made when a local authority refuses to allow trade waste to go into the sewers would be useful. Much of the difficulty which arises at the present time is probably brought about in consequence of the uncertainty of the law, but even if this were put right a Court of Appeal would be a great assistance. The Rivers Board, if one exists, naturally occurs to one as the most likely body to have the requisite knowledge to deal with questions of this kind, but on the other hand there may have been differences between the Rivers Board and either the manufacturer or the local authority which would make either the one or the other unwilling to rely on the impartiality of the Rivers Board. Failing the Rivers Board, the Local Government Board might be a body to appeal to, but against this suggestion would be urged that the procedure of the Local Government Board is slow and that the Board does not possess the requisite local knowledge, a very important factor, to enable them to deal with questions of this kind. I am inclined to think that the appointment of referee should be left somewhat open; that the parties should be allowed to appoint either the Rivers Board or some one person to decide the question, or, failing agreement, should have power to appear to the Local Government Board to appoint a referee. Another alternative would be to refer the appointment of referee to the High Court of Justice; the procedure is fairly rapid, and both sides being represented by counsel, an agreement as to reference would probably be come to; failing agreement the judge would appoint. Private actions in the High Court on questions of pollution, nuisance, etc., are now often decided in this manner.

The question of the advisability of establishing a Central Government Rivers Board is a very difficult one. Is such a Board to be confined to deciding questions between local authorities and manufacturers, or is it to eventually have the administration of the Rivers Pollution Prevention Acts? If the former, there can be no doubt that such a Board might do excellent work, provided they have the requisite local knowledge and can gain the confidence of the manufacturers and local authorities concerned. There is, however, much prejudice against Government departments whose methods are said to be slow, and their decisions unreliable, an important matter when there is no appeal. If, on the other hand, the suggested Board is to take the place of an administrative Board for the country it is of the utmost importance that their officers should be in direct and constant touch with the local authorities and manufacturers whom they have to control; a free hand must be given to them, they must personally visit the works, and make themselves familiar with the difficulties

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of each individual case; by these means alone can friction be avoided.

(7.) The expense of conforming to the requirements for the prevention of rivers pollution should, as far as possible, fall equally all round on those manufacturers who have to treat their trade waste; it seems fair, therefore, that the manufacturer who discharges into the sewers should pay the authority for doing what his competitor in the country has to do for himself.

It is claimed by those who argue that trade waste which flows into the sewers should be treated without payment from the manufacturer, that he has to pay higher rates in the town than the manufacturer in the country; but so have other manufacturers, iron-founders, etc., who have no trade waste. I do not think that, on the whole, manufacturers would object to being required to pay a special rate.

I think that the rate should be determined on the basis of volume and the cost of treatment at the outfall works, provided that any requirements under the bye-laws as to preliminary treatment are complied with; if these requirements cannot be or can only partially be complied with, the rate should be on a higher basis, which, in cases such as tanners, fellmongers, wool-scourers, etc., it would have to be very considerably higher. If town water is used for manufacturing purposes, and paid for, the local authority might probably be required to admit the trade refuse, so long as the local requirements are complied with, without payment, into the sewers. It will be for their interest to do so in order to encourage manufacturing industries, as not only will they increase their rateable value, but the community at large will derive advantages in other ways. The profit made on the water rate will more than repay the cost of treating the trade waste. If extra capital cost either on the sewers or at the outfall is required in consequence of trade wastes being admitted, this cost should be borne by the local authority, unless there are special reasons to the contrary, such as the volume of trade waste being out of all proportion to the volume of domestic sewage.

8. The reasons generally advanced by the local authority for refusing to admit trade waste into the sewers are that the sewers or outfall works are too small to deal with the extra volume, or that the irregularity of the waste, both as to volume and quality, will prejudicially affect the treatment of the sewage and cause extra expense.

All these contentions may be correct, but the importance of them and the difficulties in getting over them will vary in different cases. To increase the size of the outfall works need not be an expensive matter, but the laying of an extra sewer would be looked upon by many local authorities as too great an expense to be put to for the benefit of manufacturers. The need, however, of extra sewers, is in many cases a fact for the ordinary sewage quite apart from trade refuse, especially in old towns, where the population has increased out of proportion to the size of the sewers, the result being that the storm overflows come into use before the dilution from storm water warrants their doing so.

9. If a manufacturer uses water from a stream in his manufactory, and delivers his trade waste into the sewer, the stream will undoubtedly be diminished in proportion to the abstraction. If this procedure was allowed, many streams, especially in summer, would entirely disappear.

10. I am decidedly of the opinion that it would be very dangerous to interfere in any way with the present law affecting riparian rights. These rights are extremely valuable, industries have grown up depending on them for their existence, the water supply of towns is dependent upon them, and in many ways any alteration of the law in this respect would cause so much disturbance that it is impossible to consider it in any way practical.

13681*. (*Chairman.*) We have two sets of questions; one which we distributed to local authorities; question one being "Do you admit manufacturing refuse into your sewers?" and, second, "If so, what is the kind of refuse, and what is the volume, compared to the volume of ordinary sewage?" and then another series of questions of a more general character beginning, question one, "Are the positions and rights of the manufacturers and local authorities under the existing law clearly defined?" I take it that it is the second series of questions that you are answering in your paper?—Yes, that is so. I take those; in the first instance I went through the first set of questions that you have read out, and I think there were two questions in the other set which seemed to be rather independent of those sent to the manufacturers.

13682*. Your first statement refers to the general question, "Are the positions and rights of manufacturers and local authorities under the existing law clearly defined?"—Yes, that is so, No. 1.

13683*. Now, have you any additional remarks that you would like to make besides those which we find upon these type-written statements?—I think that that statement does include all I have to say on the matter. I think it very important that those points mentioned should be much more clearly defined than they are. Would it be convenient if I read over my remarks?

13684*. I almost think that it would be best if you will kindly read them over?—The first point which seems to me to be uncertain is, whether a local authority is bound at the present time to admit trade waste into the sewers, and if so, if they are bound, whether it is obligatory on them to make new sewers of sufficient size to admit trade waste into the sewers.

13685*. But about that, in your opinion, there is very considerable uncertainty?—Yes, I think there is, and also if you carry that further, if at the present time the sewers are too small for the admission of trade waste, are they to increase the size of the sewers, and if so, is the local authority to pay for it or is the manufacturer to share in it? Those seem to me to be the two important points; the most important points which want clearing up. Then also there is the question whether an authority has power to exclude a manufacturer from the sewers who is already in the sewers, although his trade waste may be the cause of great expense in treating the sewage.

13686*. Does that mean a manufacturer who is still continuing the same processes that he did of old, or a manufacturer already in the sewers who, perhaps, has adopted some new process by which his trade becomes the cause of great extra expense?—Well, I should say either; we have cases where a manufacturer has been in the sewers for a long time.

13687*. Yes?—We are now compelling the local authorities to improve the treatment of their sewage, and the fact of there being manufacturers in the sewage who turn deleterious matter in, becomes very much more important. Formerly the treatment of the sewage was done much more carelessly, and it was not of such great consequence if there were trade waste in the sewers.

13688*. Quite so?—And also there is a further question whether an authority has power to turn a manufacturer out of the sewers, and also, if not, whether they have power to make him carry out preliminary treatment of his trade waste before turning it in.

13689*. That is to apply to the manufacturer whether he is already in the sewers or only trying to get admission?—That is so.

13690*. Then you think it most important that those questions should be definitely settled?—I think it is very important; it would certainly help our work; it would help the Rivers Boards' work very much.

13691*. (*Major-General Carey.*) By an amendment of the existing Act?—Yes; well I would not say how it should be done.

13692*. No, but you mean that it should be done by law?—Oh, certainly, I do; yes.

13693*. (*Chairman.*) What you mean is that it should be plain what the law is?—Quite so; yes.

13694*. (*Mr. Power.*) You would put persons who are already delivering trade refuse to the sewers and those wishing to do the like on exactly the same footing?—On the same footing.

13695*. (*Chairman*). Yes, but that is another question, is it not? At present this question is simply up on the efficiency of the law, or not?—Yes.

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13696*. And we are asking you now whether the law is efficient or not?—Yes, I think that really does come under another question.

13697*. These are essential points in which you think some steps should be taken so as to make it clear what the law means?—Yes, they are. These seem to me to be the most important points.

13698*. (*Colonel Harding.*) The difficulty, of course, arises as to how we are to amend the law, Mr. Tatton, is it not? The main clauses bearing upon this matter are those in the Rivers Pollution Prevention Act, 1876, are they not?—Yes, they are.

13699*. Well, they seem fairly clear, and they state that if the sewer is large enough and if the trade effluents will not interfere either with the sewer itself and its efficiency or with the disposal of the sewage, that the authority shall take in the trade effluent. Are we likely to get beyond that? Must it not ultimately be a matter of mutual agreement between the authority and the manufacturer? Can the law be laid down so clearly as to govern all cases?—I think that you may have it clearer than it is now. I think at present they have so little basis to agree upon. The manufacturer does not know whether he has the right to claim to go into the sewers in certain cases, and the local authority does not know whether they may turn him out.

13700*. Then do you find that the chief difficulty arises from the excuse made by the local authority that the sewer is not large enough?—That is one, and also that the increased volume or some quality of the sewage will increase the difficulty of treatment of the sewage at the outfall works. Those are the two points.

13701*. The essential point that you think ought to be settled is the question as to the sewer not being large enough ought to be dealt with so as to compel the authority to put down a sewer that shall be large enough in case of need?—Either one way or the other I think it ought to be definitely settled. It does not seem to me to be clear under the Rivers Pollution Act.

13702*. From your large experience, Mr. Tatton, in the Mersey and Irwell district, do you think it is possible to so define the law as to make it applicable to all cases? Is it possible to say that an authority shall in all cases put down sewers large enough to take the trade effluents of the district; is it possible to do that?—Well, there are certain cases where you have a manufacturer perhaps with a very large works turning out a large volume of water in a small place where it would not be fair; but I think that is rather dealt with later on. I am suggesting that he should be compelled to pay an extra rate for that large volume which he turns into the sewers, but I think as a general rule in large towns that there will be no harm in saying that a local authority shall be compelled to admit manufacturers, under certain safeguards, into the sewers.

13703*. Which you refer to later on?—Yes, I refer to that later on.

13704*. (*Chairman.*) Then the second question is, should the law be altered so as to give manufacturers greater rights than at present to connect up with the sewers? That is the question which you deal with as question 2, is it not?—Yes, that is so.

13705*. And your remarks on that are?—It is generally agreed that many manufacturers, especially in large towns, are unable, owing to want of space, to efficiently treat their trade waste, and that the only means of preventing the pollution of the streams is to admit the waste into the sewers. I think, therefore, that the manufacturer should have power, under restrictions, to get admitted, and I also think that the local authorities should have power to put manufacturers already in the sewers under the same restrictions. This is not so under the existing law; manufacturers already in the sewers have a distinct advantage over those who are not, as it seems doubtful whether authorities have any control over the former unless a nuisance or some similar offence is caused by their waste, whereas, whether legally or not, they do frequently insist on making terms with the latter before consenting to take them in. It is fair in the interests both of the manufacturers and of the authorities that this should be so; the manufacturers should be all on the same basis as much as possible, and the authorities should have power to protect their interests. If the law were made clear that, firstly, manufacturers have a right to be admitted into the sewers, and, secondly, that the authorities have a right to make bye-laws to protect their interests, a great deal of the present uncertainty would be removed and the respective parties would be more likely to come to terms.

13706*. These changes you desire are such as to make clear on the one hand that the manufacturers should have the right to enter the sewer?—Yes.

13707*. And on the other hand, that the authorities should have the right to make certain restrictions?—Yes, that is so.

13708*. Both to the manufacturers who are seeking admission and those who are already in the sewers?—Yes, that is my idea; that is the lines upon which many large towns have been going. Manchester, for instance, has admitted a large number of manufacturers into the sewers under restrictions.

13709*. Yes, of course, the kernel of the whole business; there is the nature of the restrictions?—Yes, that is so. Yes, you must have restrictions; I think that is essential.

13710*. Well, ought these restrictions to be defined by the law; they could not be, could they?—Well, I deal with that later. I do not think that you could define them very distinctly, but I deal with that in further questions later on.

13711*. Later on as to what these restrictions should be?—Yes.

13712*. And in your opinion the law does not meet those points as at present existing?—No, I do not think it does.

13713*. (*Major-General Carey.*) Do you know of any cases in which the trade refuse has been admitted into the sewers, and the authority has subsequently asked for it to be taken out, as they were unable to deal with it?—Where it has been admitted lately or originally?

13714*. No; where it has been admitted for some time, we will say, into the public sewers, and where the authority say now, "We cannot deal with this trade refuse with our sewage; you must take it out or you must deal with it in some way before continuing to put it into the sewers"?—Yes; at Crompton they had great difficulty with a manufacturer. I think you have had the Clerk to the Crompton Local Board before you? I do not know whether he mentioned that case, but there was a case at Crompton of a bleacher who discharged trade waste into the sewers in very large volume which did seriously affect the treatment of the sewage. I understand the matter is in litigation, or at any rate it is going to litigation; that the manufacturer has, I believe, refused to take it out of the sewer.

13715. Has any decision been come to?—No.

13716. Are there other cases of the exclusion of trade refuse from the sewers if the Sanitary Authority object? In those cases where the trade refuse has already been admitted—for some years into the sewers—there is no precedent for the Sanitary Authority saying to the manufacturer: "You will have to treat that trade refuse before you can go on putting it into the sewers"?—I know cases where complaint has been made to the manufacturers, but I do not know of any cases which have actually come be fore the court; not in my own watershed at any rate.

13717. Supposing a manufacturer refuses to carry out any preliminary treatment, have the authority ever been able to say, "You must take your trade refuse out of the sewers altogether"?—No, I do not know any case where they have made him take it out altogether; I know cases where they have tried to make them treat it; they have represented to them that their trade watse caused a great trouble at the sewage works, and they have tried to get them to put down tanks without success. But that case has not gone into litigation at all.

13718. If an authority admit trade refuse into a sewer I suppose they take the responsibility of treating that trade waste for ever afterwards?—Yes, they do.

13719. And therefore it would be extremely difficult to alter the conditions?—Yes, I have no doubt it would be extremely difficult.

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13720. (*Colonel Harding.*) The only point would appear to be this, that there is a change in the condition of things for the local authority as well as for the manufacturer. When the local authority allowed the manufacturer to turn into the sewers the local authority was not compelled to purify what passed through the sewers, so that new conditions have arisen ?—Well, new conditions make them feel it very much more.

13721. The question of prescription would appear to some extent to be dependent on whether or not new conditions had arisen, but probably that is a legal point which neither you nor I are able to discuss ?—Yes, that is so.

13722. (*Chairman.*) There is another point, Mr. Tatton, brought before us just now, that the local authority were justified in interfering with a man who is already in the sewers because they had undergone changes as to their duty with regard to the disposal of their sewage ?—Quite so.

13723. (*Colonel Harding.*) That ought to affect the legal position ?—That is a legal question. Of course you might say that the local authority ought to have treated the sewage properly; they were supposed to be doing so always; their legal position was wrong in not doing so.

13724. Then questions 3 and 4, which you take together, really refer to these restrictions which are referred to in question 2, do they not ?—Yes, they do; that is so.

13725. They are restrictions which are safeguards to the authority in admitting the rights of the manufacturer to pass into the sewer ?—Yes, they are.

13726. And in your answer, I suppose, you state generally what are the main safeguards which you think ought to be adopted ?—Yes, I do.

13727. And those are ?—In the first instance, the trade waste which is discharged into the sewers must not interfere with the due flow of the sewage; it must not silt up in the sewage. That is one thing. And also no effluent should be turned into the sewer which may by itself or in combination cause explosion. The safeguards required should secure, firstly, with regard to the sewers, that no damage should be done to them or interference caused with the free flow of the sewage, that no refuse should be turned into the sewer which may by itself or in combination cause explosions or cause a nuisance or do harm to the workmen engaged in the sewer. The safeguards should also secure with regard to the outfall works that the treatment of the sewage should not be unduly interfered with either through the waste being turned in irregularly, say a large quantity at one time, and a small quantity at another, or through the waste containing anything which makes the sewage difficult or unreasonably expensive to treat.

13728. I see there you consider first of all, the sewage while it is in the sewers, and then the treatment at the outfall ?—Yes, two points have to be guarded against, any harm being done either to the sewers or to the outfall works.

13729. Then is your opinion that these safeguards should be secured by some legal statute ?—Yes, it is.

13730. You pass on, I think, to suggest how the safeguards might be arranged ?—Yes, as regards the safeguards to the sewers, tanks must be provided at the factory to intercept the coarser solids which would be liable to settle out in the sewer, and also those tanks must be sufficient to equalise the flow of the sewage at the outfall works. But, of course, they need not be so efficient as would be required if the trade waste were discharged from them into the rivers naturally. As to their capacity, I think it should be governed partly by local conditions, and if the trade waste is discharged into a sewer where the fall is very slight, where there is a sluggish flow, and where the solid matter would be more likely to settle out, the tanks would have to be of larger size. And also the effect of trade waste is very often to act as a precipitant. That certainly takes place in the streams, even although the effluent may be quite clear apparently to the eye, when it is discharged into a stream sometimes it will cause precipitation and make the stream look quite muddy below, and no doubt the same effect would take place in the sewers.

13731. These are safeguards which you think should be secured by law ?—Yes.

13732. There would be, I suppose, relatively little difficulty in adopting the words which would cover your general statement, but there would be considerable difficulty in securing the details which you are now dealing with, would there not ?—Oh, yes; you could not put details as I have drawn them out into the Act, of course, but you might give a local authority power to appeal to whatever authority was put as the arbitrator over them, which we discuss later on, if these conditions were not fulfilled.

13733. May I take it in this way, that your answer in the first place states what are the safeguards which should be defined in general terms by the law, and then your answer goes on to show how these might be carried out in detail ?—Yes, quite so.

13734. But for the carrying out in detail you would want something else than the mere statement of the law ?—Oh, certainly, most decidedly.

13735. (*Mr. Power.*) You would want power to enforce bye-laws, would you not ?—Yes, you would; that would be very essential.

13736. The Act should give power to enact bye laws ? —Yes, quite so.

13737. (*Major-General Carey.*) Or regulations ?—Yes.

13738. (*Chairman.*) And the details on which we are now dwelling are such as might form the basis of the proposed bye-laws ?—Yes, that is what I should suggest.

13739. I suppose these are rather illustrations than definite proposals ?—Illustrations of what we want to arrive at.

13740. (*Colonel Harding.*) I should be very glad if Mr. Tatton could have told us precisely what the alterations are that he would suggest in, for instance, Section 7 of the Rivers Pollution Act ?—At the end of Section 7.

13741. (*Chairman.*) Section 7 has to be considered in connection with Section 21 of the Public Health Act, has it not ?—Yes, that is so.

13742. That gives wider powers in a certain sense ? —Yes, it does in a certain sense, and yet it does not seem to me to be very clear. It says that they shall give facilities for enabling manufacturers within their district to carry liquids, and so on.

13743. (*Colonel Harding.*) You would like to put that more strongly, would you ?—I should like to put that more strongly. It does not say that they shall take.

13744. (*Chairman.*) Might it be put in this way, that Section 7 as at present standing, directs sanitary and other local authorities to give facilities to manufacturers, but under the proviso enables the local authority to refuse to admit the manufacturers ?—Yes.

13745. You wish the law so altered that the local authority shall admit all the refuse of all kinds ?—Yes.

13746. But the proviso should be that the manufacturer should so treat the refuse as to safeguard the local authority ?—Yes, quite so, that is what I mean.

13747. Under the present Act the local authority could not give the facilities; might refuse to give the facilities to the manufacturer by reason of these provisos ? —Yes.

13748. Which would throw the manufacturer entirely out of the sewers ?—Exactly.

13749. Your contention is that the local authority should be compelled to admit the manufacturer, whatever his refuse, but that the refuse should be so treated as to safeguard the local authority in respect of the treatment of their sewage ?—Well, whatever his refuse is, with the provisos that I have mentioned.

13750. Yes ?—Yes, quite so; that is to say, supposing it would cause any injurious effect to sewers or cause explosions, and so on.

13751. Quite so ?—Exactly, that is my meaning.

13752. But the point is the local authority must admit the manufacturer provided the manufacturer will submit to restrictions ?—Yes, that is what I mean.

13753. (*Major-General Carey.*) One of these restrictions being, of course, the regularity of flow ?—Yes,

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certainly; yes, that is very important indeed, the regularity of flow.

13754. That is not mentioned at all in Section 7?—No, not at all.

13755. (*Colonel Harding.*) I understood Mr. Tatton was not prepared to say at a moment's notice what exactly was the alteration that he proposed?—In words?

13756. Yes?—No, I am not prepared to say that.

13757. What I wanted to get at was that that Section 7 of the Rivers Pollution Act does now say that the local authority "shall give facilities for the admission of trade effluents," provided that certain contingencies do not arise. It is difficult to see how you could get beyond that; I thought perhaps you might have some practical suggestions?—I think that is so very much modified by those provisos that the first part of it is no use.

13758. You think the provisos are too strong?—I think the provisos are too strong.

13759. You think that the principles of the admision of trade refuse to the sewers should be laid down more strongly and that the restrictions should be better defined?—Yes, I do.

13760. (*Chairman.*) Perhaps you would like to do away with Section 21 of the Public Health Act, Section 7 and Section 16 of the Rivers Pollution Act, and provide another clause?—That is what I should like to do, and draft a clause simpler to understand.

13761. (*Colonel Harding.*) And you find the local authorities if they do not want to take effluent into their sewers could refuse?—Yes: do frequently shuffle out of it.

13762. All that adds difficulty to the duty of the Rivers Board that there is no means of getting the matter settled at all?—It adds very much to our difficulties. We have a manufacturer now that we have been negotiating with for a long time, who says he means to get admitted into the sewers; the local authority say they will not admit him; neither of them take action; we get no further.

13763. Do you not think it would be possible to modify the law to compel the local authority within a definite time to give an answer and state the conditions, if any, upon which they would admit the effluent?—I do; make it clearer in the Acts of Parliament.

13764. We have in the West Riding Rivers Board local authorities drifting along for years without giving any definite answer one way or another?—They will do; I have found that.

13765. It would be a distinct improvement in the condition of things if the law compelled the local authority within a reasonable time to give a definite answer and to state the conditions, if any, upon which it would admit the effluents?—Yes, it would be a great assistance. I should like to point out that although it is desirable, no doubt, that the tanks which a manufacturer puts down at his works should be as large as possible, perhaps holding a whole day's flow of his waste, it is not really essential. Many works are situated in towns where there is not sufficient room to put down large tanks at all, and in those cases I would suggest that a manufacturer should be required to use, under the words of the Rivers Pollution Act, "the best practicable and available means" to deal with his trade waste. It is far better that he should have small tanks than no tanks at all clearly.

13766. (*Chairman.*) That means that in certain cases the safeguard which the local authority would demand might be extremely limited?—Yes, it might.

13766* Which would be a precedent, would it not?—And if they can compel a manufacturer to use "the best practicable and available means" to treat his trade waste, supposing he says, "I cannot put down tanks of more than a certain size," if they could point out to him that he could put down tanks of a larger size, they would prove that he was not using "the best practicable and available means."

13767. In order that the manufacturer's refuse should be admitted into the sewers they must be so treated whatever be the size of the tanks that neither the flow of the sewage nor its treatment is materially interfered with?—Well, I deal with that later. Supposing his treatment is materially interfered with, what you might do is to make the manufacturer pay a higher rate for that, because in some cases it is impossible to bring them up to a high standard; I mean to say to a standard which would not interfere at all.

13767*. With the general treatment of the combined sewage?—Yes; I do not say that it would interfere seriously, but it would interfere to some extent probably.

13768. There are two cases, are there not, at least there are two possible cases, one where the refuse which the manufacturer discharged into the common sewers was such as to compel the local authority to use much more expensive methods for treating their whole sewage?—Yes.

13769. But there would be cases in which the admission of the refuse would so interfere with the sewage that it could not be treated at all?—Oh, there would be no doubt if he did not take measures to treat it at his own works.

13770. Well, in the latter case what would be your position, because I mean there is no question of a rate for the extra expense; the sewage cannot be treated at all satisfactorily?—Well, I think the latter case in practice would hardly ever be found. I mean to say that it would be very seldom that it would be impossible to find on a man's premises space in which he could put down works which would prevent it in any way interfering seriously with the treatment of the sewage. Where they have a large volume of water, say a manufacturing dyer, who, perhaps, uses over 50,000 gallons of water a day, the bulk of that water is washing water, and that as it is now is fairly well distributed over the day. The waste which causes the trouble is the more concentrated waste from his soap vats and from his dye vats, and so on, and that is the waste which he wants to spread over the whole of the day, and treat at his works.

13771. (*Mr. Power.*) Are the two sorts of waste almost separately discharged at the same sewer; they have to execute some works to separate the discharge?—They would have to do that at some works.

13772. They would require that?—They would require that. That would not be a very expensive business. As a rule they have separate machines for doing the work; they have washing machines where the bulk of the water comes from, and they have their dye and soap vats and so on, which are separate.

13773 (*Chairman.*) Then I gather your general conclusion is that either there would be no difficulty in making the manufacturer so treat his refuse that the sewage could be treated in the ordinary way, or that he could treat it to such an extent that all that would be necessary would be to charge him an extra rate for the extra trouble that is thrown upon the general sewage?—Yes.

13774. Those would meet all cases?—I think so.

13775. Question 5 is a special case of grease, is it not; solids, grease, and so on?—Yes, that is so.

13776. Your more general conclusions apply to that, I suppose?—They do; of course, in certain cases, chemical treatment would be required at the works; that I should certainly hold.

13777. (*Mr. Power.*) You would regulate by byelaw the sort of treatment that they would have to adopt in the particular trades; you would for instance require chemical treatment by bye-law?—Quite so; yes, by bye-law.

13778. For particular classes of refuse you would prescribe chemical treatment?—Yes, I would.

13779. That would be by bye-law regulation under the Act?—Yes, and also for the case of waste pickle from galvanising works.

13780. That would want special regulation again?—That would want special regulation and dealing with, and distributed over the whole of the day. If it is sent over in large volume it causes great trouble, and if it is spread over the day it acts as a precipitant in the sewage.

13781. (*Mr. Stafford.*) Who would you propose should make these bye-laws?—I should propose the local authority should make these bye-laws in the first instance.

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13782. Would they be subject to anybody ?—They would have to subject them to the Rivers Authority, or which ever authority was established.

13783. It would not do to leave the local authority the unrestricted right to make bye-laws as they liked ?—Oh, no.

13783.* (*Chairman.*) Then Question 6 refers to this proposal of the tribunal, such as the Central Government Rivers Board ?—Yes.

13784. To whom appeals can be made ?—Some tribunal to whom appeal can be made when a local authority refuses to allow trade waste to go into the sewers would be useful. Much of the difficulty which arises at the present time is probably brought about in consequence of the uncertainty of the law, but even if this were put right a Court of Appeal would be a great assistance. The Rivers Board, if one exists, naturally occurs to one as the most likely body to have the requisite knowledge to deal with questions of this kind, but on the other hand there may have been differences between the Rivers Board and either the manufacturer or the local authority, which would make either the one or the other unwilling to rely on the impartiality of the Rivers Board. I feel that that might occur.

13785. (*Colonel Harding.*) Do you think that generally the Rivers Board would be accepted by the parties ?—I think it would, I must say.

13786. As sufficiently impartial to settle their differences ?—I think generally it would.

13787. But of course you give a further power of appeal from the Rivers Board to another body ?—Well you might do that.

13788. Would not that be absolutely necessary, because there are cases you yourself suggest in which the Rivers Board might not have the confidence of both parties ?—Yes, I think that if you make the Rivers Board the authority you must give an appeal from it ; on the other hand, if you made the Local Government Board the authority, or a Central Board the authority, I do not think it is necessary to have an appeal. You have not an appeal now from the Local Government Board.

13789. (*Chairman.*) Would you have no appeal from the Rivers Board ?—Yes, if you make the Rivers Board, then I should have an appeal, because the Rivers Board is connected with both—the two sides of the question—and may have had some trouble with one or other of them before.

13790. In your statement I see the words "refuses to allow trade waste to go into the sewer," but according to what you have already said in evidence there are to be no cases of refusal. The question arises as to the conditions which the local authority is imposing ; that is what you mean ?—Yes, that is what I mean.

13791. Perhaps it would be as well to modify that ?—Yes, I should like to modify that.

13792. It is really the conditions which the local authority imposes ?—Quite so, yes.

13793. Either as a Rivers Board, or an appeal beyond the Rivers Board, you are suggesting the Local Government Board, are you ?—Yes, that occurs to one as a possible Court of Appeal, or possibly some referee might be appointed by the Local Government Board. It is a question whether the Local Government Board would have local knowledge sufficient to my mind to deal with these matters. They might refer it to a referee.

13794. But the Local Government Board can acquire local knowledge, can they not ?—Yes ; they can do that, yes, but I think it is very difficult when you, I was going to say, are not always amongst these sort of questions, to get that knowledge.

13795. But are there not certain difficulties connected with the appointment of a referee, that is to say, a single individual appointed for the cases ?—Yes.

13796. And you get different referees appointed for different cases, and their conclusions do not always agree, and the action of one referee might be in contrast with the action of another referee at a different place or a different time, which is unsatisfactory, is it not? —It is certainly very unsatisfactory, but I think you would be liable to the same thing from the Local Government Board.

13797. Would you be liable to the same difficulty in a Central Board, such as has been suggested, about which you find, I see, considerable difficulty. You see the possibility of establishing a Central Government Rivers Board. By that you mean one which would do away with all the special Rivers Boards, or a Board which should be a high court of appeal beyond those, which, I think, is rather the suggestion which has been made ?—Yes ; well that was rather my difficulty in answering the question. I did not understand quite whether it was intended to make the Rivers Board a large Central Authority to deal with the whole of the rivers of the country, or whether it was to deal with these special questions only. If the latter, well then I think it would be very difficult to get the local knowledge. You would not have sufficient questions of this sort arising. If the law was fixed definitely I do not think there would be so many as there are now.

13798. Yes, but supposing this Central Board is a Board of Appeal, allowing all the Rivers Boards to go on as usual, and do what they can, which is brought into action only in certain cases, surely it would be the duty of this Central Board to avail themselves of all the local knowledge which they could gain access to ?—Quite so.

13799. Is there not much to be said in favour of a permanent Board, whose actions would form, after a while, precedents, and establish a rule of action, rather than individual referees appointed *ad hoc*, giving often diverse opinions. I mean the Central Board would establish after a while a homogeneous set of decisions.

(*Mr. Power.*) It would have its expert knowledge.

13800. (*Chairman.*) It would have its expert knowledge ?—Given those conditions I quite agree that would be satisfactory.

13801. It would be a Central Board, which would have at its disposal the most complete expert knowledge, including a knowledge of all local difficulties, but it would be a permanent body ?—Yes.

13802. And so to speak a homogeneous body, whose decisions would be homogeneous as regards place and as regards time ?—Quite so. Well, given these conditions, if you have a Board of that description I think it might very well be referred to it.

13803. You would on the whole, perhaps, think that better than the referee ?—Yes, I should.

13804. Then I think you have really answered already in regard to the manufacturers paying a special rate or charge in those cases where they are allowed to connect with the sewers ?—I think I have answered that.

13805. I mean you state at all events that they ought to pay a special rate when not being able themselves to treat the sewage before it is being discharged into the sewer, and so costing extra expense to the local authority ?—Yes, that is so.

13806. You have already said they ought to pay a special rate ?—That I have said so.

13807. But this question, perhaps, rather refers to the matter generally, whether all trade refuse received should pay a special rate or charge ?—Yes, that is so. Well, my opinion is that they should pay a special rate, and I do not think that manufacturers would be averse as a rule to do so.

13808. But why should they pay a special rate ?—Well, other manufacturers in the country who have not access to the sewers have to pay for the treatment of their trade waste, and I think it is only fair that manufacturers in the town should also contribute towards a payment of the treatment of the sewage.

13809. Supposing their trade refuse does not necessitate any special treatment of the general sewage, and therefore no additional expense to the local authority, why should the manufacturers pay a rate other than that of the ordinary ratepayer for his domestic sewage ?—Well, in any case you would have the extra volume, and it will cost so much more to the authority to treat it ; you will have so many million gallons a year extra

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to treat, and that whatever the cost to the authority may be.

13810. (*Sir William Ramsay.*) Might I interpose a question. What becomes, for instance, of the clinker of an ironworks; does the ironworks dispose of it, or is it undertaken by the town ?—The ironworks dispose of it as a rule.

13811. Is an arrangement ever made with the town by which it may be removed by the dust cart or by special carts ?—Well, I fancy it varies in different places. In some towns certain manufacturers pay to have their ashes removed.

13812. Pay the town ?—Oh yes, that is so.

13813. Would not a work which has trade effluent to dispose of be very much on a par with an ironworks which has its clinker removed by the town, and which pays the town to remove its refuse ?—Almost every kind of works has some sort of refuse as a rule, and they have to remove it.

13814. (*Colonel Harding.*) At their own expense ?—At their own expense.

(*Sir William Ramsay.*) Or by an arrangement with the town ?

13815. (*Colonel Harding.*) Yes, by an arrangement. In nine cases out of ten it is removed at their own cost ?—At the cost of the manufacturers ?

13816. Yes ?—Yes, that is so.

13817. (*Chairman.*) If the manufacturer is to pay a rate on account of his large volume, then you would wish, I suppose, some regulation with the owner of a premises discharging into the common sewer beyond a certain volume, should pay a certain rate. You would allow a certain volume of sewage to be paid for by the ordinary rate ?—No, I do not think I should. I think I should make him pay for the whole; he would have to pay for it if his works happened to be situated in the country. I think that what you want to do is to put all the manufacturers as much as possible on the same basis. They complain now very much; those who have to treat their waste in the country complain very much that manufacturers in the towns are admitted at no cost specially, and I think there is good deal in that complaint. They are their competitors, and you should equalise the cost as much as possible.

13818. On the other hand it is a hardship on the manufacturer against the ordinary resident of the town who is using the sewers only for domestic sewage ?—Well, it is a very much smaller volume in that case He pays the rates for it; of course the manufacturer pays the rates for it, you may say, in the same way, but I do not think that seems to me to be on the same footing quite. You have one man who may perhaps discharge 100,000 gallons into the sewers of trade waste.

13818.* Yes, but the rate should be according, not to the size of the premises, but the amount of the volume discharged into the sewer ?—Yes, I should put it on that, certainly.

13819. (*Mr. Stafford.*) Irrespective of the quality ?—No, not irrespective of the quality. What I think is, that the rate should be determined on the basis of volume and the cost of treatment at the outfall works, provided that any requirements under the bye-laws as to preliminary treatment are complied with. If these requirements cannot be or can only partially be complied with, the rate should be on a higher basis, which in cases of tanners, fell-mongers, wool-scourers, etc., would have to be very considerably higher.

13820. (*Chairman.*) You really have two rates, I mean, one being mere volume which might interfere with the actual process to which the common sewage is subjected ?—Yes.

13821. And another for the increased expense necessitated by special treatment ?—Yes.

13822. Of the whole sewage ?—Yes, I should.

13823. Then (8) refers to your experience, as to what are the difficulties the manufacturers meet with ?—Yes. The reasons generally advanced by the local authority for refusing to admit trade waste into the sewers are that the sewers and outfall works are too small to deal with the extra volume, or that the irregularity of the waste, both as to volume and quality will prejudicially affect the treatment of the sewage, and cause extra expense.

13824. Well, the second one may be considered as having been met by your previous suggestion ?—Yes.

13825. But how about the first one that the works are too small ?—That the outfall works are too small.

13826. Yes, either the sewers or the outfall works are too small. That. I suppose, if the rate is according to the volume, would also be met ?—Well, in that case I think that the local authority should be called upon to pay the extra cost of the outfall works, or of the increase in the size of the sewers. In many cases the sewers are much too small now; they just take the dry weather flow, and as soon as ever there is a storm of rain, they overflow into the rivers. In many towns that is the case—most of them I may say—and it is not, therefore, fair for the local authorities to say, "No, we will not take you in, because our sewers are too small," when for their own sewage they ought to have much larger sewers.

13827. And do you think that would cover the majority of cases, so that you are prepared to recommend that the local authorities should be compelled to enlarge their sewers ?—Yes, I am; I think it is logical.

13828. The difficulty being partly met by your suggestion that the manufacturer should pay an extra rate for his large volume ?—For the treatment of their trade waste.

13829. That would not affect the outlay at the beginning, but it would pay them afterwards ?—Yes.

13830. Then question (9) refers to the riparian rights involved ?—I think it would be very unwise to interfere with the present riparian rights, because manufactories have been established all over the country depending on those rights, and any interference would be most serious. I do not see how that could be thought of.

13831. Well, those are what you kindly place before us; are there any other remarks that you would like to make, now that you are with us ?—Well, the question of the manufacturer discharging his waste into the sewers, and if he uses town's water, I think that that might be an exception to the ordinary case; that if he buys water from the town he might then be allowed to discharge his trade waste, under, of course, the bye-laws, without payment, of course the town getting an advantage, they making a profit out of the water which he uses.

13832. Your suggestion is that the bye-law might cover that ?—Yes, I think so.

13833. That if he uses the town water that should be really credited to him ?—Yes.

13834. For a diminution of his rate ?—Well, yes, I should not charge him then the sewage rate for the treatment of his trade waste—the extra rate.

13835. That is the ordinary rate ?—Yes, quite so.

13836. The rate for increased volume that you spoke of ?—Yes, that is what I mean; I mean the ordinary rates; of course he would pay in the ordinary way.

13837. But you propose that he should have an increased rate for his extra volume, and that you would remit if he drew his water from the town sources ?—Yes.

13838. Of course, if there were special treatment required and a special rate for that, that you would insist upon ?—I should insist upon that, yes.

13839. But the mere extra rate which you are proposing on account of the extra volume should be remitted in cases where that extra volume is really drawn from the town water ?—Yes, I should.

13840. (*Major-General Carey.*) But the town supply is not always given by the Corporation or by the authority; the town is very often supplied by a public company ?—Quite so; well, then I should not. It would not apply in a case like that, because he would have to pay the company.

13841. (*Chairman.*) How did you propose to measure the volume when you wanted to determine how to rate a man on account of his volume; would you have a

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meter, or how ?—Yes, perhaps you might have a meter ; perhaps that would be the most convenient way of doing it.

13842. Any other way of doing it ?—When he had put down tanks to treat it you could gauge how long it took to fill the tanks ; measure the water in that way for several days in succession, and get an average in that way.

13843. (*Sir William Ramsay.*) If you used a meter would it make it very difficult ; would it not make the manufacturer discharge regularly, which very often he does not wish to do ?—Well, that is one thing that you are going to insist upon ; that is what I suggest should be insisted upon, that he should discharge regularly. Then you would have a meter on the lower side of his tank so that the water should be regulated before it gets to the meter. By that means I think you would get over the difficulty.

13844. (*Chairman.*) Then with regard to the other increase in the rate, namely, the increased rate which you charge on account of the extra expense to which the local authority is put in treating the sewage because the manufacturer cannot treat it himself, how would you proceed to form an estimate as to what the amount of that rate should be ?—I think it is very hard to form an estimate, very difficult.

13845. But you will have to do it if you impose it ?—I think if you impose it you will find that he will treat it in every case.

13846. So that is a threat ?—Yes, it is that. I think you want to have that power of charging him extra if he does not do it.

13847. And you charge him just so much as would compel him to do it ?—Well, you have to compel him to do it somehow, and it is very difficult to.

13848. (*Colonel Harding.*) Still there are cases, Mr. Tatton, where a man cannot possibly fulfil any conditions, having no land whatever, and in that case the authority would be bound to do it ?—Yes, the authority would be bound. I think there would be very few cases of that sort where he could not put down some sort of works.

13849. (*Chairman.*) Would it be possible for the authority to make some estimate as to the expense to which they had been put in treating the sewage altered as it has been by this man's untreated refuse being thrown into it ?—I think they could form some sort of estimate. I think that you must make him pay something extra if he does not do it the same as other people. That is how I feel, because you have cases of very bad trade waste. For instance, you have fellmongers discharging into the streams, and woollen manufacturers, and you must have some means of compelling them to treat their trade waste, supposing they say, "We have not got room."

13850. Are there any other points you would like to bring before us besides those ?—No, I do not think there is anything else.

13851. (*Colonel Harding.*) I should just like to recur once more to the very important point which seems to be the crux of the whole business, of the difficulty between the local authorities and the manufacturers as to whether you really think that the law ought to compel the local authority to put down a sewer large enough to take any volume of trade effluent that may be offered to them. How can you suggest that that should be done ; what kind of safeguards could be given by the local authority ?—When you say any volume that may be sent down, I presume you mean in comparison.

13852. Well, if the law is that an authority is bound to receive trade effluent, and if the sewer is not big enough, to make it big enough ; if the law were to lay that down it might bring about the most serious condition of things for some local authorities. I understood you to say that you thought the law ought to be laid down ?—Yes, I think as a general rule ; that is my feeling about it.

13853. As a general rule, but what is the nature of the safeguard ? Would you have some limit as to the relative volume ?—You might do that ; that would be a possible way, but not a very satisfactory one.

13854. Take the case of a local authority which has a very limited amount of domestic sewage ; there come some large works to be established within the district of that authority, turning out a volume probably half-a-dozen times or ten times as big as that of the domestic sewage. Well, is the authority to be compelled in that case to relay its drainage for the sake of that one manufacturer ?—Well, in a special case like that it seems fair that the manufacturer should have to contribute towards the construction of the sewer.

13855. Your answer to that difficulty is that the manufacturer being a ratepayer could be rated by the local authority at such an amount as would cover the cost ?—He would have to pay for the treatment of his sewage.

13856. Well, he would in that way ?—And I should make him pay that at any rate.

(*Chairman.*) But in addition you would levy him for the additional cost of the increase of the sewers.

13857. (*Sir William Ramsay.*) *Pro rata* with the other people, I suppose ?—I think he ought to.

13858. (*Colonel Harding.*) But you do not hesitate to suggest to the Commission that the law ought to throw upon the local authority a liability to receive trade effluent however large its volume may be ?—As a general rule I should say it ought: but there might be special cases which would present difficulties.

13859. (*Chairman.*) Those might be referred to the Central Board ?—You might do that ; you might have power to do that.

13860. That means of course that there would be an appeal in every case I suppose to the Central Board ?—Oh, I think not, because you would not have many cases of that sort.

13861. (*Colonel Harding.*) Surely there must be power of appeal. It is quite clear that if you are to lay down a general condition of things like that, a general condition of liability, there must be power of appeal in special cases ?—Oh, certainly ; but what I mean is, those special cases would not very often arise where you have a manufacturer in that position, at least not from my experience.

13862. Then, speaking generally, quite apart from this legal point, do you think it advisable that local authorities should undertake the wholesale purification of trade effluents or that individual manufacturers should carry out that work themselves ?—In the country or in the towns ?

13863. Say in the town. From the point of view of rivers pollution, is it better in your opinion that the authority should deal with it wholesale or that the individual manufacturers should do it themselves ?—In the town certainly the authorities should deal with it.

13864. You think that probably the work will be better done ?—Yes, I do.

13865. And that the supervision in the case of each individual manufacturer carrying out the work would be extremely difficult ?—That is one point, and the other point is that the manufacturer has not sufficient room to do it thoroughly in the towns on his own premises ; he can only do it partially, which is not satisfactory so far as the rivers are concerned.

13866. From your experience on the Rivers Board, if every manufacturer were compelled to deal with his own effluent, the supervision would be almost impossible ?—It is not so much a matter of supervision that concerns me as that he is not able to do it in many cases efficiently.

13867. But if he were able to do it he would have to be constantly watched, would he not ?—Oh, certainly.

13868. As a general rule, you think it advisable from point of view of rivers pollution that the local authority should receive trade effluents and deal with them wholesale ?—In the case of large towns ?

13869. Yes ?—Yes.

(*Chairman.*) The whole of the refuse untreated ?

13870. (*Colonel Harding.*) No, I did not suggest that to Mr. Tatton, but that the local authorities should receive the trade effluents under such conditions as they

consider fair, and deal with them wholesale ?—Yes, under such conditions.

13871. And in such cases probably it would be found one would neutralise another, and the work would be facilitated ?—No, I should not go so far as to say that. I think the effect of taking trade waste to the outfall works does no doubt complicate the treatment of the sewage ; it does not facilitate it.

13872. I did not suggest that it would facilitate the treatment of sewage, but in some cases for instance, if you had a trade effluent which was alkaline, instead of each individual manufacturer neutralising it, the probability is that if an acid effluent were allowed to flow into the sewer they would neutralise each other ; therefore there might be such cases in which it might be an advantage to deal with them as a whole rather than separately ?—In Rochdale where there is a large number of manufacturers engaged in the woollen trade there is a large amount of grease coming down and nothing to neutralise it.

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13873. If there is nothing, there is nothing ?—I do not think there would be very much of that.

13874. (*Chairman.*) Of course, where there is a large amount of grease in the refuse you would insist that where practicable it should be removed before it went into the common sewer ?—Yes, I should ; it is very important indeed.

13875. (*Major-General Carey.*) Even if the sewers are enlarged by the local authority to take both the domestic sewage and the trade refuse, I suppose there would be numerous cases in which the sewage disposal works would not be sufficient and in which there was no space for enlarging ?—Oh, yes, no doubt there would be. They would then have to apply to the Local Government Board for powers to enlarge them.

13876. If they could ?—If they could, but then of course the same question arises on the increase of population.

FORTY-SEVENTH DAY.

Wednesday, October 15th, 1902.

PRESENT :

The Right Hon. The EARL OF IDDESLEIGH (*Chairman, presiding*).

Sir MICHAEL FOSTER. K.C.B., F.R.S., M.P.
Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Mr. W. H. POWER, F.R.S.
Colonel T. W. HARDING, J.P.
Dr. JAMES BURN RUSSELL.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, Secretary.

Dr. W. S. SQUIRE, called in ; and Examined.

Dr. W. S. Squire.

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13877. (*Chairman.*) You are here representing the Society of Chemical Industry ?—Yes.

13878. Are you of opinion that the Rivers Pollution Acts which are at present in force require amendment ? —I think so, yes.

13879. Might I ask you if you can give us any reasons for that ?—Well, it appears to me that with that Act there is nothing definitely settled at all ; that a man is not allowed to run his trade waste into the rivers unless he can show that he has adopted the best plan he can in order to purify it. Well, that is extremely vague. Then I may say that it is rather a matter for the local authority to carry out this Act or not. Now, in London, as I know quite well, there are considerable difficulties. In fact, we are not allowed to run anything into the Thames at all unless it is of a very clear character ; but in Glasgow, where I have considerable practice, there seems to be absolutely no restriction whatever, so that in that respect certainly the Glasgow manufacturer is at an advantage over the London one. For example, distillery refuse is run in without any objection whatever, and nothing is likely to produce a nasty smell and mess so much as distillery refuse. In the first place it is not at all clear, and it holds a quantity of nitrogenous matter in solution, and suspension, and when it gets into the rivers it gradually deposits and makes a stinking mess. But that is allowed in Glasgow, and not in London, so that there appears to be really no definite rule to follow or that is followed.

13880. Do you consider that any general rule could be laid down with regard to modern scientific methods of purification ?—No, I think each case must be treated on its own merits. It is impossible to lay down a general rule for purifying all and every effluent. They have a totally different composition, and contain different substances in solution and suspension.

13881. And are you of opinion that it would be a good thing to have a tribunal, a special tribunal, to which all cases of difficulty could be referred ?—Certainly, I think it should be so. In fact, I would suggest a kind of parallel, not necessarily an exact parallel, with the Admiralty Court, where a judge who knows probably little about the matter in hand is advised by a number of experts who do.

13882. (*Sir William Ramsay.*) But, Dr. Squire, would you have the same judicial tribunal with assessor in this case, or would you have a special court ?—I would have a special court. A certain number of assessors who are permanent assessors. Of course, you can call in any further assessors you like. No doubt, in a great many cases there would be expert evidence called on either side, which would be worth about as much as expert evidence generally is.

13883. I do not quite understand. Do you propose to have here something in the nature of the Inspectors under the Alkali Act, who in a sense constitute a kind of minor tribunal, the advice of which is generally taken ? Of course, in case of dispute they raise an action ?—Yes.

13884. Is that what you propose ?—Well, I do not lay down exactly any particular scheme, because that is a sort of thing I am not conversant with at all, but I think the matter ought to be referred in any case of difficulty to experts, not merely lawyers.

13885. (*Sir Michael Foster.*) But the court, or whatever it is proposed to have, its opinion, its judgment, would be final ?—Oh, yes.

13886. I take it, what you complain of chiefly is want of uniformity ?—Precisely.

13887. Would you wish to see introduced some new Act which would apply to all authorities ?—Yes. I take it the Rivers Pollution Act in a general way does that already, but in practice there is very little uniformity.

13888. Then it is not the Act so much as the practice that you complain of ?—It is the practice, yes.

13889. And how do you propose to remedy the want of practice ?—Well, I do not know that you can improve

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very much upon the existing Act if it is carried out strictly.

13890. Yes, but what steps would you take in order to compel it to be carried out? If the Act is one which is not carreid out surely it is an inefficient Act?—Or it is inefficiently carried out as it is; it depends entirely upon the local authority to carry it out or not, I take it.

13891. What you are contending for are certain general principles to be laid down which should be obeyed by the local authority; the special application of those principles to be submitted to experts so that each case may be judged on its own special features?—Precisely, that is really what I am contending for.

13892. But you do want general principles laid down? —General principles laid down which should be interpreted by a competent tribunal.

13893. Which would compel the local authorities to put the Act in force?—I should say, certainly.

13894. (*Sir William Ramsay.*) But in the case you have specified, that of Glasgow, the Act could not be applied?—In which case?

13895. The Glasgow case?—Do you mean the distilleries?

13896. The works that turn their trade refuse into the Clyde. I mean the Clyde is considered as a tidal river?—It is a tidal river, so is the Thames.

13897. But in the one case it is applied and in the other not?—Yes.

13898. Why is that?—I do not know. I do not like to mention names, but when I was in Glasgow, the Distillers Company there got into considerable difficulty about it. There were in the same sewer certain products run down from Tennant's Chemical Factory, and they were more or less alkaline, and contained hypo-sulphites, and the usual things that come away from an alkali work. The spent wash that came down from Port Dundas Distillery was very acid; well, acid to the extent of about one per cent. of lactic acid; when they came into contact, of course there was a considerable evolution of sulphuretted hydrogen. If it were clear spent wash that came down from Port Dundas it would probably not do much harm, and possibly the dilute liquid which came down from Tennant's would not do much harm, but the two together made a terrible smell.

13899. (*Chairman.*) I might just observe that I believe that there is a special Act which applies to the Thames only?—Yes, I believe there is. Of course there is no doubt about it that the river is the ultimate way in which everything is got rid of. That applies almost without exception, and of course what has been done is to render the effluents as innocuous as possible. In some cases it has to be done in one way and in some cases in another. It is quite impossible to lay down a general rule of treatment. Now, I have had considerable experience with distilleries. There is no doubt that distillery spent wash is a most magnificent manure; in fact, it carries back to the soil everything except the alcohol which has been extracted, of course, from the air; all the salts go back. But the work of a large distillery in a month would represent perhaps all the grain that would be raised in a county, so that you cannot get rid of it in that way, because if you put on too much you do more harm than good, although it is splendid manure. It might of course be got rid of in that way, but it would require an enormous expense in the matter of pipes and so forth. In order to clarify spent wash with a view to running it into a river, long settlement is necessary. The suspended matter is carried about by convection in the hot liquor during cooling. The addition of alum facilitates deposition in the case of spent wash, but of course that does not apply to everything.

13900. (*Major-General Carey.*) Do you consider that there should be a preliminary treatment of the trade refuse in all cases?—In those cases where it is necessary.

13901. Only in cases where it is necessary. There might be cases where it would not be necessary?—Yes, I recollect when Dr. Perkin had his factory at Greenford Green he used to produce his chlorine for the alizarine works from bleaching powder and hydrochloric acid, and what he had to send away was practically chloride of calcium. Well, that did not seem to do any harm in the canal at all; in fact, the doctor said the fish rather gathered round it when it was coming out into the canal. If that was so or not I do not know.

13902. (*Sir Michael Foster.*) It is a question of quantity, is it not?—It is a question of quantity; I think all these things are a question of quantity.

13903. (*Dr. Burn Russell.*) Is it not the case that this question of the disposal of trade refuse does not become acute until the local authority are considering some scheme of general treatment of their sewage?—Well, the trade refuse would have to be treated in many cases in a totally different way to the sewage.

13904. Yes, but it is generally the case, I think, that as long as the local authorities, as in the case of the Clyde in Glasgow, are satisfied in allowing everything to go into the river, and thereby to the sea, that no question arises about trade refuse, but as soon as they begin to consider a scheme of treatment they are compelled to consider it?—No doubt that would be so.

13905. You are aware, of course, that Glasgow, in the Police Act of 1866, has got a clause dealing with that matter of the offensive results of the combination of different kinds of trade refuse in the sewers. Section 339 of the Glasgow Police Act enables them to deal with the refuse of any trade or manufacture which is of such a nature, which, if suffered to flow directly or indirectly into any ordinary public sewer, will cause, or be liable to cause, by itself, or by admixture with other matters therein, noxious or offensive effluvia, but that clause only goes the length of taking it by a pipe direct to the Clyde?—That is so, but I do not know any case in which it has been acted on.

13906. But now, Glasgow having embarked on a scheme for the treatment of their sewage, have got powers in a special Sewage Act to deal with the trade refuse which is likely to interfere with the efficient treatment of the sewage passing through the sewers, so that in that way the conditions will be equally stringent on the Clyde as on the Thames?—The Lord Provost of Glasgow in several speeches that he has made—he is very fond of making speeches——

13907. He is very good at making speeches?—Very good indeed; excellent; he is always asking people, "Will anybody tell us what we will do with that which we take out of our sewage, when we purify it."

13908. Ah! Well, they have embarked on a scheme that will cost them over a million of money?—Yes.

13909. And before they will have expended all that they will know something about it?—Yes.

Mr. Ellis.

Mr. ELLIS, called in; and Examined.

13910. (*Chairman.*) You are a member of the Surrey County Council?—Yes, I am an Alderman of the Surrey County Council.

13911. May I ask you whether you are of opinion that a clearer definition of the legal position of local authorities and of manufacturers is required?—That is decidedly my opinion. I do not know what you think is best as a matter of procedure, but I have put down a few notes here, which perhaps will be rather more terse than any answers I may give.

13912. Would you mind reading them out to us?—I shall be pleased to do so.

"I may introduce myself as a tanner, having factories in Bermondsey and at Shalford, Surrey. This latter has been in the hands of my family for over a century, and has an easement into the river Wey, a tributary of the Thames.

"I know but little of the troubles as to sewage which are met with by manufacturers in the large centres of industry in the North of England (except by repute); my experience and my knowledge have been gained in the South of England, where, as a rule, factories are isolated and few in number. It is of their requirements and of their difficulties that I speak.

"The Rivers Pollution Prevention Act of 1876 greatly affected the position of manufacturers, and it was made an offence to put into a stream 'any poisonous, noxious, or polluting liquid proceeding from any factory or manufacturing process,' but there is internal evidence in the Act to show that its framers were by no means inclined to harass the industries of the country, and they probably thought that by Section 7 they were giving reasonable compensation for the great advantages hitherto possessed by manufacturers.

"At the present time Section 7 in the Rivers Pollution Act of 1876 is really all the manufacturers have to trust to (if we except Clause 21 of the Public Health Act of 1875, to which I will presently allude), and difficulties and litigation cluster around its interpretation and that of its qualifying provisions. These, in my opinion, should be made perfectly clear. The Section 7 is as follows: 'Every sanitary or other local authority having sewers under their control shall give facilities for enabling manufacturers within their districts to carry the liquids proceeding from their factories or manufacturing processes into such sewers.'

"The expression 'give facilities for' is treated as ambiguous by the legal mind, and is certainly more so than the wording of the 21st Section of the Public Health Act, 1875, where it says that 'the owner or occupier of any premises within the district of a local authority shall be entitled to cause his drains to empty into the sewers of that authority.' In itself this appears clear enough, and in some cases the decisions of the Courts have been in favour of the manufacturers; but Lord Halsbury has expressed the view that it was never intended that a manufacturer should be allowed to use the drains for his sewage, and this point should be made perfectly clear.

"The limitations to Section 7 of the Rivers Pollution Act are very considerable.

"The first appears perfectly reasonable: 'That no liquid which will prejudicially affect the sewers be admitted.'

"The second is of little moment now, seeing that the more modern methods of treatment are not affected by it. It was of importance when the resulting mass was expected to be a good manurial product.

"The third I do not consider as important, but in the next paragraph of the section which says 'that no sanitary authority shall be required to give such facilities as aforesaid where the sewers of such authority are only sufficient for the requirements of their district,' we get an expression which local authorities are, and will be, very ready to take advantage of. When owing to an increase of population sewers prove insufficient they have to be enlarged by the local authority, and one fails to see why some of their largest ratepayers should not have the same privileges as the smallest householder.

"I hold that a distinct obligation, clearly stated, should rest on the local authority to deal with manufacturers' sewage, and that the onus should rest on that authority in showing that it was noxious or otherwise infringed the provisions of the Act.

"That reasonable safeguards might be required by the local authority as to the condition and regularity with which sewage was delivered.

"That a small tribunal should be established in each county to which all disputes arising between manufacturers and local authorities should be referred, and that the procedure of such should be speedy and inexpensive. The constitution of such a body as this should include representative business men knowing well the requirements of the district, and a paid representative of the County Council, as in the Thames Conservancy Act.

"That in those cases in which manufacturers have been deprived of their prescriptive rights without compensation, they should be entitled to the privileges of ordinary householders, viz., that of putting into the sewers all their sewage without any other charge than the ordinary district rate.

"But that in the case of new factories where the volume of sewage is altogether out of proportion to the rateable value, the local authority should have power to make a special charge dependant on the volume and character of the sewage, and that, failing an amicable arrangement between the parties, such question be referred to the tribunal alluded to, but that the obligation of receiving and dealing with the sewage is not weakened or removed thereby. (I need hardly say that the assumption underlying this contention is that the public at large benefit by country manufacturers, and therefore it is the duty of the local authorities to foster them, and by that means to assist in solving the housing problem as well as that of the depopulation of the country districts and the prevention of congestion of population in large cities.)

"I hold that difficulties arise between the manufacturers and the local authorities:

"(*a*) From doubt on the part of the authorities as to the character of the sewage.

"(*b*) As to the volume of the same which they may have to treat.

"(*c*) As to their ability to deal with it under the system which they may be practising, and

"(*d*) A belief that it is unfair that the ordinary ratepayer should be involved in increased expenditure for what they regard as the private advantages of the manufacturer. This belief induces them to take advantage of the ambiguity and want of clearness of the Acts mentioned, and they possibly take one of the following courses:—(*a*) They refuse to take the sewage, leaving the manufacturer to take legal proceedings against them; (*b*) they plead the insufficiency of their plant and their fear of the effect of trade sewage mixed with household sewage; or (*c*) they take care that their drains are not laid in the neighbourhood of the factory; and (*d*) in one case that I know of they have tied their own hands by buying ground for a sewage farm, with the proviso that nothing but household sewage goes thereupon."

13913. Now, may I ask you about this question of tribunals. You would advocate a separate tribunal in each county?—I should.

13914. Then do you consider that a committee of the County Council in each county would not be a capable tribunal?—My experience of County Council committees is that they would be capable, but it seems to me imposing a burden on them that they can hardly be expected to take. I should strongly advocate a representative on that tribunal as there is on the Thames Conservancy. As you are probably aware, the gentleman who represents us on the Thames Conservancy gets an honorarium of £100 a year for doing so. A very able man, Mr. Burt, is our representative.

13915. Would your idea be that the members of this tribunal should be paid?—Well, I can hardly express an opinion upon that. When I say that I think a representative of the County Council should be paid, I admit it would be quite an exceptional position; but assuming that there was a great deal of work for it, and that it was work that was not altogether germane to the work of the Council, it seems to be reasonable that you should pay a man in that position.

13916. What would you say to a central tribunal, say a central tribunal in England and another in Scotland and another in Ireland; do you think it would be necessary to have a tribunal in each county?—My own idea is that it would be most practical, and that matters would be settled with less friction if there was a tribunal for each county where the requirements and nature of the different manufactures were known more. Now, of course, if we take the southern counties you may just put down in two or three words the different manufactures that are carried on there in the agricultural rural districts. I do not think that the conditions that apply there would apply at all to the northern manufacturing districts, where, as I understand, the volume of sewage, or at any rate of discoloured water, is so immense that it counts by thousands of gallons where we should speak of gallons.

13917. Still, do you not think it is rather a formidable thing to start sixty or seventy new tribunals?—It is doubtless, but I do not think that there would be very much for them to do. I do not imagine there would be; certainly not in the southern counties.

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13918. (*Sir Michael Foster.*) But would not that increase the difficulty to establish all these numbers if there is so little for each of them to do ?—Well, I should not assume that they would be all standing at any rate, although they might be nominated and act when required. They might be called upon to act when necessary.

13919. (*Sir William Ramsay.*) Could you give us some idea of the kind of persons who would serve on the tribunal besides the representative of the County Council ?—I should think it would be necessary in the first place to have a first-class chemist. I would mention such a man as Roscoe ; that he should have a retaining fee. My views would run in that direction. I think you would want one man like that. Then you should have a representative of the manufacturers, it seems to me, perhaps selected by the manufacturers themselves. Probably he might not be a manufacturer, but he would be their representative.

13920. (*Mr. Power.*) You would have one or more experts permanently retained then ?—I should.

13921. (*Sir William Ramsay.*) Who might be common to a number of such tribunals ?—Exactly.

13922. (*Colonel Harding.*) They would not be really members of the Board, but they would be experts to be consulted by the Board ?—Exactly ; well, that would be a question of arrangement. I should say possibly experts consulted by the Board, but I should suggest a very small tribunal ; I have always found that that is best.

13923. (*Sir William Ramsay.*) Three or four people ? —Yes ; five I should suggest.

13924. (*Colonel Harding.*) Has it occurred to you that there might be a Watershed Board dealing with the whole course of a river of considerable importance ? —Yes, quite so.

13925. And therefore dealing with a larger area than the bodies you are contemplating ?—Well, I have not thought of that ; that might be possible. Of course, in our district we have such very stringent regulations by the Thames Conservancy that it overrides everything else. Their requirements are very onerous indeed.

13926. Then in fact, you have a Water-shed Board now ?—Yes, so far as the Thames is concerned.

13927. The Thames and its tributaries ?—The Thames and its tributaries, yes.

13928. (*Sir Michael Foster.*) But you are unwilling to use them as the tribunal in question ?—Yes, undoubtedly.

13929. Why, if I may ask ?—Well, they are required by the legislature to so carefully look after the purity of the water—when I say purity I mean the purity of it as drinking water—that as to the facilities which should be given in my opinion in connection with the disposal of sewage they could have nothing to say. I have had a good deal to do with them, have always been on excellent terms with them, but find they are most careful in carrying out the law, and they say they cannot regard the requirements or necessities of manufacturers at all ; they have simply one thing to do—keep the Thames and its tributaries absolutely clear.

13930. (*Dr. Burn Russell.*) But if the water is to be potable would you ask them to do anything else ?—If the water is to be——

13931. To be potable ; to be used for drinking purposes ?—Yes.

13932. Would you suggest that they should be otherwise than extremely rigorous ?—I am quite satisfied with the stringent operations of the Thames Conservancy provided we get the power to put our sewage into a drainage system, and insist on the district authorities maintaining and keeping the drainage system for us. I think that is the only way of making the matter effective. At the present moment, for instance, my firm are spending several hundred pounds a year in dealing with our own sewage. We have had our easement practically cut off. We are dealing with our own sewage. We have to devote three acres of land to it and are involved in great current expense besides the initial cost in the first place, and we manage thereby to appease and satisfy the Thames Conservancy, but the difficulties with the local district authority are very considerable indeed. They are shirking, as I think, their duties on some of the pleas which I have mentioned here.

13933. (*Sir William Ramsay.*) But would it not be more difficult to treat your refuse—a tannery refuse, and a pretty bad one ?—Well.

13934. If it were mixed up with the ordinary sewage of the district for treatment ?—There was a case, the last case that has been tried—the Attorney-General and the Sevenoaks Rural District Council *v.* Whitmore, and there was a great deal of professional and technical evidence given there, but the outcome of it was distinctly that if tannery refuse were combined with household sewage there was no difficulty of treating it ; that was Roscoe's view, or rather his representatives, and that obtained the credence of the Judge absolutely over all the other evidence that was put before him.

13935. You would undertake to make its flow regular ?—I think that is a thing that the authority has a right to require.

13936. It would give you no great difficulty to comply with ?—It would involve us in expense, but I do not think unreasonable expense. I think that absolutely reasonable.

13937. (*Chairman.*) At present is your refuse treated on land, and does the effluent then go into the Thames ? —My refuse is treated entirely by filtration through land.

13938. And the effluent from that flows into the Thames ?—And the effluent from that flows into the tributary of the Thames.

13939. Then how long have you treated your refuse on land ?—For about five years.

13940. And before that ?—It always went into the tributary of the Thames.

13941. Without any treatment ?—Just a settling tank, just as we do in London ; for instance, we have no trouble in London, not the slightest.

13942. (*Colonel Harding.*) Did I understand you to say that there was an easement which had been cut off ?—Well, when I said "cut off" I should not have said that perhaps, but practically for sewage it has been cut off ; it is now only available for pure water.

13943. Then do you suggest that you had been connected with any sewer and that connection had been cut off ?—No. That was the case of the Eden Bridge tannery that I alluded to. In that case the authorities had years ago requested a tanner to connect with the sewers, and they finding difficulty in treating his stuff with household sewage, required him to cut it off.

13944–5. There was no legal contention on the point ? —Oh, yes.

13946. Was there ?—Oh, yes. He cut it off temporarily, but he contested their right to insist on this, and he beat the authorities absolutely. He beat them in the first place at a trial at Maidstone before Mr. Justice Day, I think. Then it was carried to appeal and the Master of the Rolls, Lord Justice Vaughan Williams, and Lord Justice Romer, were unanimous in awarding that the authority was responsible for the dealing with this sewage, and that they must adopt a system which would deal with it effectively. It has been the most valuable decision that we have had.

13947. Then was the decision quite apart from any question of prescriptive right ?—Quite.

13948. It was on the merits of the case that the Judges declared that the authority ought to take it ?—Quite so, absolutely.

13949. It was not on the question of long connection with the sewer and prescriptive right ?—No, that was not mentioned at all in the judgment of the Master of the Rolls. He did not say a word as to the fact that they had been invited to attach and then been required to disconnect ; he did not allude to that, he simply relied on this Section 7 of the Rivers Pollution Act. It all hinged on that.

13950. Did the manufacturer, in fact, reconnect to the sewer ; has that manufactory been reconnected

to the sewer ?—Certainly, yes; but the difficulties arose there from the fact that the authorities had not a very good kind of ground to deal with and they were mismanaging—they were proved to have mismanaged their system absolutely.

13951. (*Sir William Ramsay.*) I think you mentioned that you had no difficulty in London; have you a tannery in London ?—Yes.

13952. What becomes of the refuse there ?—It all goes down the drains.

13953. Is it treated ?—Not the slightest; all sewage goes into the settling tanks, the solids settle, and the effluent runs into the drains. The volume of sewage that is put into the drains by the Bermondsey Tanneries is immense.

13954. And is that treated at all before it reaches the Thames ?—Not in the slightest.

13955. (*Colonel Harding.*) Can you tell me if any nuisance arises in the drains themselves in the neighbourhood of the tanneries; are there any local complaints as to great stench arising from the ventilating shafts and so on ?—Some years ago there was a little trouble, and I think there were some preliminary legal steps taken, but the tanners showed their right to put it into the sewers, and we never hear of any difficulties arising now, or rather, only this, that sometimes there is a complaint made that there is too much solid matter; the sewers are choked perhaps by solid matter getting in; but otherwise, with respect to the smell or the character of the sewage, I have never heard of a complaint for many years.

13956. (*Dr. Burn Russell.*) Is that solid matter which has passed through your settling tank ?—Yes. Of course there is no doubt the settling is evaded to a great extent in some cases. There is a very thick liquor which we call "lime liquor," the refuse of lime pits, and if it is stirred up it is almost of the consistency of cream. Well, if a tanner lets that go, of course, it would naturally settle in the sewers and cause a good deal of inconvenience, but that is a thing that is generally prevented.

13957. And how do you dispose of this solid matter; the residuum in your settling tanks ?—In London it is now rather a serious matter. It is manure, and at one time we used to be able to give it away, and let people come and fetch it and take it without any cost to us, but now there is such a long cartage that we generally have to pay about 2s. 6d. per ton for the carting away of the settlement.

13958. Then if your analogy between the rights of a householder and a manufacturer were fully carried out you would have a claim to get this solid matter removed by the local authority just as the householder has to get his ashes ?—I do not think so, because I doubt very much whether it ever has been the right of the manufacturer; whether it has ever been his right to put solid matter into the drains. The only case in which I urge that the manufacturer ought to have that compensation, so to speak, is where an easement has been cut off, or rather, he is prevented from using the same facilities for disposal which he used to have.

13959. (*Sir Michael Foster.*) Do I gather from you that if the Thames Conservancy took some stricter, proper view of their duties, some such view as is taken for instance by the Rivers Boards in other districts, you would be disposed to regard them as a suitable tribunal, there being just only one tribunal for the whole watershed ?—I do not wish to suggest that the Thames Conservancy have not taken a strict and proper view of their duties.

13960. It was rather to the character of their conduct and to their constitution to which you objected ?—My experience has shown that the Thames Conservancy and the district councils are always at loggerheads. For instance, in a local inquiry which we had a few months ago in our own district, the County Council sent its medical inspector, Dr. Seaton, and the Thames Conservancy sent their man, Mr. Drummond, to watch their interests; and the attempt, of course, of the Thames Conservancy is to do away with any possibilities of pollution and get the district authorities to have sewering facilities and to take all this stuff in, so that the Thames Conservancy is now pressing our Local Board to carry out their scheme of sewerage, which will in my case, for instance, take away all the trouble and at a very small expense, whereas now it is a very large expense and a great deal of trouble.

13961. Any difficulty arising between such a body as the Thames Conservancy and your District County Council might be met by an appeal to a higher authority—a central tribunal ?—Quite so; I think there should be a right of appeal to some higher authority.

13962. As for instance, a special tribunal constituted to deal with adequate knowledge with a question referring to rivers pollution ?—To be sure; exactly.

13963. I gather the general trend of your evidenc is the law as at present interpreted rather acts in favour of the local authorities ?—Undoubtedly.

13964. You would have it so changed as to act more in favour of the manufacturers with certain reasonable safeguards ?—Yes; it seems to me if the 21st section of the Public Health Act of 1875, distinctly said that manufactories were included in the term premises, and that the manufacturer is entitled to put his sewage into the drains—which Lord Halsbury seems to deny, the thing would be plain, and that would give us a great help, and that is all I want.

13965. That is all you want ?—That is all I want.

13966. That the local authorities should *prima facie* be bound to receive the manufacturer's refuse ?—Exactly.

13967. But that the local authority should have power to demand such reasonable safeguards as might be required ?—Exactly, quite so. And I should myself be quite inclined to admit that when the volume was very large, altogether out of proportion to the assessments, that they might have a right to levy a special rate.

13968. A special rate ?—I know of one place where that is done. At Godalming, not many miles from me, they have very good sewage works in connection with the town, and the beds are very well managed. They meet the requirements of the Thames. Conservancy, and I have never heard of any trouble There are two large tanners in Godalming, and all their effluent goes into the sewers, but it goes through a meter, and it was an arrangement between the town authorities and the manufacturers when the sewerage scheme was first started that meters should be used; all the stuff should be run through them, and over and above a certain quantity should be paid for at a given rate. I could not say what the rate is; I do not think it is known.

13969. Although the local authority might charge a special rate for a large flow of sewage, the initial expense of say enlarging their sewers so as to take in that extra quantity should fall simply on the local authority ?—I think so; I think so distinctly. And in connection with that there seems such an absolute want of clearness on the part of the local authorities when they are sewering a district as to whether there is any obligation on them to provide for manufacturers' sewage; many of them deny it distinctly.

13970. And you want it made clear that they must provide ?—Certainly.

13971. With certain safeguards ?—Yes, make a manufacturer pay if you like, but do not do anything which will involve the shutting up of that manufactory. This has occurred in our business in several places in England.

13972. I suppose that apart from the volume, if the refuse is of such a kind as to entail very large expense, additional expense to the local authority for the treatment of the sewage you would admit a special rate then ?—I should.

13973 (*Colonel Harding.*) We are very anxious, Mr. Ellis, to have your opinion as to the alteration of the law that you would propose. You were telling us just now that you thought it would suffice if in Section 21 of the Public Health Act it was distinctly stated that not only domestic sewage, but trade effluent should be received into the sewers ?—Exactly, yes.

13974. But in the Rivers Pollution Prevention Act, Section 7, surely that is distinctly stated. Every sanitary or other local authority having sewers under

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their control shall give facilities for enabling manufacturers within their district to carry the liquids proceeding from their factories into such sewers?—Exactly.

13975. Well, but that has not helped manufacturers very much, has it, that statement which is fairly clear?—I also thought it was clear and satisfactory till I consulted legal advisers, and they said, "Oh, we do not read it at all in your way; 'to give facilities for' is a very different thing from throwing the obligation distinctly upon the authority."

13976. (*Sir Michael Foster.*) Have there been judgments to that effect?—I do not know that there are. I do not know any case in which that has been tried, but the unfortunate fact is this, that as I have mentioned the local authorities leave the manufacturer to take action in so many cases and the manufacturer of course hesitates very much before he does take action. He feels that he is going to law with a powerful public body, and even in the case at Eden Bridge, where something like £7,000 was expended, and all the recognised costs fell upon the local authority, yet the tanners were mulcted in that case in over £1,000.

13977. (*Colonel Harding.*) Then is your view that the alteration of the law should be such as to emphasise distinctly the obligation of the local authority to receive trade effluents?—Exactly.

13978. And to throw upon the local authority the onus of showing that the effluent is noxious?—Exactly.

13979. And that preliminary treatment is required?—Exactly.

13980. Or that a special contribution by the manufacturers is required?—Certainly.

13981. The onus of proving all that, you want to throw upon the local authority?—I do, distinctly.

13982. Then I should just like to ask a question as to your own treatment of the effluent from your own works. It would be rather interesting for us to know the results that you are able to obtain from your works at Guildford?—It is near Guildford, about three miles off.

13983. Is the volume considerable?—I have 14,000 gallons a day.

13984. And it is of the usual foul character coming from tanneries?—Yes.

13985. Would you be good enough to state what preliminary treatment you give before you put it upon the land?—I have a field adjourning.

13986. (*Sir Michael Foster.*) How much land have you at your disposal for the purpose?—Two and a half acres are devoted to that. In the field, which is about three acres, I have large settling tanks, capable each of holding about 4,000 gallons—6,000 gallons, I think, of the liquor is pumped up into these. We use these tanks alternately, that is we should fill one this morning and we should let that settle for the afternoon; that would then be run off into the beds. When I say "beds," I mean just the large reservoirs in the ground.

13987. (*Colonel Harding.*) It is quiescent settlement?—Yes, quite so. We use no chemicals whatever. I think it is the opinion, certainly of Roscoe and of Voelcker also, that chemicals are a great mistake, that the best filtration is the filtration of the ground itself, and that is what we use. Well, then we have a succession of beds, the liquid goes first into one, and if it does not filter through the earth sufficiently fast, when that bed gets full the surface water, which, of course, is the clearer, runs over into the next one.

13988. (*Sir Michael Foster.*) They are in different levels, the beds?—Yes, different levels.

13989. (*Colonel Harding.*) What are these beds?—They are simply earth embankments round the ground.

13990. (*Sir Michael Foster.*) What is your soil?—Fortunately, a light, sandy soil.

13991. (*Colonel Harding.*) What is the nature of the liquid flowing from the settlement tanks; is it fairly free from suspended solids?—Yes, distinctly so.

13992. But highly discoloured, I suppose?—Very highly discoloured; it is black in fact.

13993. Then what effect is produced by its passage through one filter bed?—Well, in the first filter bed there is generally a certain amount of residuum which involves us in the expense of cleaning out that filter bed perhaps twice in twelve months.

13994. What is the depth of it?—Well, it is about 18in.; not more than that.

13995. And you empty the material out or either renew it or wash it out?—We run the liquor away and let it dry on the surface, and then the sediment is taken out.

13996. Then in passing through that bed it is an intermittent action, or is it continuous?—Oh, it is continuous.

13997. Then it is not suggested that it is bacterial action at all?—No, it is not.

13998. And it is largely mechanical, is it?—I am speaking of my own case; I believe if I wer egoing to make arrangements again that I should try to give a little more ground and get the bacterial action.

13999. By giving intermittence and oxidation?—Certainly.

14000. Then you pass it after this first over a second bed?—Yes.

14001. Then what is the final result?—The final result is that it has all gone through the ground.

14002. Do you mean that it disappears utterly?—It filters distinctly away; we know nothing of it.

14003. (*Sir Michael Foster.*) May I ask what is the bottom of your first bed?—Simply the natural soil.

14004. (*Colonel Harding.*) Then is there no effluent from the process?—There is a very small amount sometimes, but we know nothing of it as a rule. In a dry season we know nothing of it, I am glad to say.

14005. The soil available is sufficiently large to drink up the effluent such as it is, good or bad, probably bad?—Yes, we have had difficulties with continuous rainfall, 3in. or 4in. coming in 24 hours, and still putting up a very large quantity. We have found a difficulty in keeping this going. We have drains, that is one large barrel drain, sunk at about 8ft. down, which connects with the ditch, and this ditch with the tributary of the Thames. When we are obliged to let it down there we can get it so that it really passes as a very fair effluent, though it is not quite what we like.

14006. You satisfy the Thames Conservancy?—Yes, we do.

14007. Would you be at liberty to state to the Commission at what cost to your works these results are obtained?—In the first place I sacrifice the ground, which in that neighbourhood is very valuable, say £400 an acre—£300 an acre—then the initial cost of the works was about £350. The current expense is about, taking the year through, 30s. per week. That is dealing with the residuum and taking care that everything is going right, and clearing out the tanks.

14008. (*Sir Michael Foster*). 14,000 gallons a day?—Yes.

14009. (*Colonel Harding.*) We hope we may take it that it is not too serious a burden upon your business; it is a perfectly practical expense for a manufacturer to go to?—Well, it is, but we are very heavily burdened now. Of course, it is just one of the things which would prevent me, for instance, if I had to begin *de novo* from removing a factory from London into the country—just one of these things.

14010. (*Sir Michael Foster.*) I understand, Mr. Ellis, that it is the top 18in. of your first bed that you are from time to time changing?—Exactly.

14011. You take away the old stuff and put new stuff on?—I have had to do that in one case, and I have no doubt I shall have to do that every year—one bed.

14012. The second bed you leave alone altogether?—Yes.

14013. It is only the top water from the first bed which flows into the second bed—the surface water?—That is so.

14014. And it is the surface water of your second bed which flows into your third bed?—Yes, it is just a series of tanks at different levels, and from the settling tanks it flows into the highest one.

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14015. What does not pass through the first bed passes into the second one ?—And in the first bed there is very little that soaks through, because the ground itself gets coated over with a sort of slime.

14016. But it is that which you remove from time to time ?—It is that which we remove, yes.

14017. (*Chairman.*) You have kindly told us what the cost of the treatment of your sewage is to you. Now, do you suggest either that the treatment is more than is really sufficient, or that you ought to be relieved of part of the cost ?—I am the largest ratepayer in the parish, and I think that seeing that there is a sewerage system now going to be carried out for my parish that they ought to take my sewage, but they are going to try to shirk that apparently.

14018. (*Mr. Power.*) Ought to take it without preliminary treatment; or are you going to give preliminary treatment ?—Oh, I would do anything in reason ; if they called upon me to make it an effluent without any settlement, or anything of that sort, I think I should meet them in every way ; I am quite prepared to.

14019. (*Chairman.*) Then you would say that your own local authority ought to take your sewage into their system of sewers ?—Certainly, absolutely.

14020. What happens to the sewerage of the local authorities ; that finds its way into the Thames somehow, I suppose ?—Yes, distinctly. If I am not taking up too much time I should like to explain the position of this local authority at Guildford, or rather Shalford. For some years they have been pressed by the Thames Conservancy and by the County Council to have a system of sewerage in our village—in our parish.

14021. (*Sir Michael Foster.*) What is the population ? —2,000. They have at last made up their minds that they must have this, and a sewerage scheme was prepared, which took in what we call the three different sections of the parish. It is a large parish, and it divides itself naturally into three different sections. This involved an expenditure of something like £20,000, which was thought to be very high. The authorities then said "No, we will drop one of these sections, and we will drop the section where Mr. Ellis's tanyard is." So they have a Local Government Board enquiry, and come before the Commissioner and they say : "We do not propose in the first place to make a drainage area, but we propose only to drain two sections of the parish," and for that they want something like £15,000. The Thames Conservancy were present, our sanitary officer of the County Council was present, and both of these authorities urged on the Local Government Board that the whole parish should be drained. We have not got the decision of the Local Government Board, although this inquiry took place over six months ago. I have reason to believe that the Local District Council will be advised that no obligation rests on them to provide sewers for my sewage, under the 7th clause of the Rivers Pollution Act, and that I be left to take such action as I may see fit.

14022. (*Chairman.*) Who is it exactly who says they do not recognise the obligation ?—I understand that is the views of their legal adviser.

14023. (*Mr. Power.*) Is it an Urban Council ?—No, a rural.

14024. There are three groups of population in the parish ?—Yes.

14025. And your works are associated with one group that they do not propose to sewer for at all ?—Yes.

14026. Domestic sewage or manufacturer's ?—Precisely.

14027. What group of population is left out ?—Speaking roughly, I should say about 500.

14028. Out of the 2,000 ?—Out of the 2,000.

14029. Nearly a quarter ?—Yes.

14030. (*Sir Michael Foster.*) The sections are distinguished not only geographically, I suppose, but by their character ?—Yes, they are.

14031. One is more residential ?—Yes, rather more so.

14032. (*Mr. Power.*) Is there a public water supply, and do you use the public water for your works ?—Yes ; well, we use the water from the river to a great extent, although I have water laid on from Guildford in the event of emergencies, and at my private house I have water laid on from Guildford.

14033. From the Wey you get your water ?—From the Wey, yes. There is another case as showing the action of the district authority very near us, and to which I alluded in my remarks. A large landowner sold the local authority land for the purpose of their sewage work, but on condition that nothing but household sewage came on it. At that time only a portion of the parish was drained, or ordered to be drained, but since that the Local Government Board have insisted upon the whole of the parish being drained. There is a large tannery there in which the owner is put to about the same expense, I presume, that I am myself. He happens to have ground near him, and he is able to do it, but they have absolutely tied their own hands. They cannot take manufacturer's sewage into this ground, which they have bought with the proviso that they are not to take manufacturer's sewage on it. I should not have thought that such a transaction was a legal transaction.

14034. It is one of the conditions of sale you mean hat they shall not take it ?—Yes.

14035. (*Chairman.*) Going back to your own village for a moment, was it not allowed that the £20,000 to provide for the sewage of 2,000 people was a very large sum ?—Very large ; it is a scattered parish.

14036. Who prepared the scheme ?—I think the plan that was adopted was proposed by a Mr. Moon, who has done the work at Godalming, done it very satisfactorily and fairly economically.

14037. But what sort of scheme was it ; was it to treat the sewage on land or how ?—Of course the Local Government Board required them to have land even if they adopt the bacterial system, and they were going to adopt the Cameron system, but also to have about 12 acres of land, which they have bought for that purpose.

14038. Twelve acres ?—Twelve acres.

14039. And was the purchase of that land the bulk of the expense ?—No. They had to buy that under compulsory powers, and to pay nearly £200 an acre for it, but the great expense is involved in pumping stations They get three pumping stations in the parish to raise this sewage to the proper level.

14040. (*Mr. Power.*) To take it to one outfall ?—Yes.

14041. (*Chairman.*) There is a great deal of pumping to be done ?—Yes, a great deal of pumping.

14042. (*Sir Michael Foster.*) Was that bargain for the sale of the land that the use should be limited to domestic sewage submitted to the Local Government Board ?—I have no knowledge as to that, but I assume it must have been ; I should not have thought they could have carried it through without.

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14043. (*Chairman.*) Are the positions and rights of the manufacturers and local authorities under the existing law clearly defined ?—On the whole, yes ; but there are one or two points upon which perhaps legal decisions are required rather than the alteration of the law. (*a*) The right of the sanitary authority to impose conditions upon the manufacturers, or make bye-laws for regulating the admission of trade refuse to the sewers. (*b*) The position of manufacturers who have, for a prescriptive period, been discharging their refuse into public sewers and whose refuse may be shown to be, in its crude state, a hindrance to the proper purification of the combined sewage. (*c*) The power of the local authority to make a charge for the purification of trade refuse admitted to the sewer.

14044. Should the law be altered so as to give manufacturers greater rights than at present to connect up with the sewers ?—No, the rights of the manufacturer

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seem to be at present as complete as is fair to the sanitary authorities.

14045. Are any further safeguards required to secure that the refuse shall be delivered in such a condition and in such regular quantities as not to interfere with the purification of the sewage ?—The authorities should have power to make bye-laws and conditions as mentioned in (*a*).

14046. Should further safeguards be required, what should they be and how best could they be enforced ?—Such regulations as have been adopted by Leeds, Keighley, etc., would seem to be sufficient and can only be enforced if the authorities have legal power to make them.

14047. Are the manufacturers prepared to adopt means for the removal of suspended solids, grease, etc., from their trade refuse before being allowed to discharge into the sewer ?—As a rule the manufacturers who at present are not discharging to public sewers are prepared to adopt such means, and the better class of manufacturers whose premises are at present connected with public sewers are also willing, but the majority of those who think they have a prescriptive right to discharge crude refuse without regulation into the sewers will not adopt any such means unless they are forced, and those who are willing object to carrying out necessary works if their competitors in trade are allowed to escape this expense.

14048. Should there be some tribunal to whom appeal could be made when a local authority refuse to allow trade refuse to go into their sewers ?—A special tribunal would be very advantageous in dealing with many of these matters. (*a*) They could decide whether conditions or bye-laws drawn up by sanitary authorities are reasonable. (*b*) Whether in special cases where a site for purification works is difficult to obtain, these conditions should be relaxed, or in other cases made more stringent, and whether in certain cases a money payment should be made by the manufacturer.

14049. Should manufacturers be required to pay a special rate or charge in those cases where they are allowed to connect with the sewers ?—This is one of the questions which a tribunal, if constituted, should be able to decide. In some cases the whole welfare of the district depends upon manufacturers turning out liquid trade refuse, who pay a considerable proportion of the rates; in these cases the Sanitary Authorities would probably act wisely in foregoing any special rate. In other cases, as for instance where the manufacturer erects premises in a residential neighbourhood, it is certainly right that he should pay the sanitary authority for dealing with the trade refuse, but in all cases any special rate should be levied equally upon manufacturers who have for a prescriptive period been discharging into the sewers, and upon those whose trade refuse may have been recently admitted to the sewer. The claims of manufacturers that they already pay large sewer rates and should therefore have their liquid trade refuse dealt with at the sewage works of the sanitary authority is quite untenable when closely examined. In the first place such a manufacturer is rated equally with owners of spinning mills, mines, railways, etc., from none of which is liquid trade refuse discharged In the second place, a manufacturer discharging any large quantity of trade refuse never pays in sewer rates anything approaching the sum required to pay for the treatment of his trade refuse. For instance, the occupier of a dwelling-house paying rates upon say £40 a year, and occupied by eight persons, would send into the sewers about 200 gallons of sewage daily. The occupier of a dye-house rated at £200 (five times the former amount) may discharge 100,000 or 200,000 gallons daily of refuse (equal to 500 or 1,000 times the amount of domestic sewage in the former case). The occupier of a woollen mill or brewery, or tannery, rated also at £200, may discharge many thousand gallons of a liquid infinitely worse and more expensive to purify than domestic sewage. The amount of any special rate would require to be determined upon the basis of the quantity and nature of the trade refuse to be dealt with, and its effect in increasing the difficulty of dealing with the sewage at the sewage works and upon the extent of the preliminary treatment to which it was subjected by the manufacturer. No doubt a sanitary authority would show special consideration for manufacturers who purchased their water from the authority. All these points would naturally fall to be decided by a special tribunal if such were created, failing agreement between the manufacturer and the sanitary authority.

14050. What are the difficulties the manufacturer usually meets with in dealing with local authorities, and what are the reasons generally advanced by local authorities for refusing to allow trade refuse to go into sewers ?—The real difficulty the manufacturer meets with, in inducing the local authority to admit trade refuse to the sewers, is that the authorities fear the increased difficulty and greater cost of dealing with the mixed sewage at their sewage works. Another difficulty is that the authorities fear to take any water which has been drawn from streams, the abstraction of which may lead to legal proceedings.

14051. What would be the effect upon the flow of the water in the streams if the trade refuse were diverted from them into the public sewers, and is any alteration in the law so as to permit of the abstraction of dirty water from the streams desirable ?—In some neighbourhoods the diversion of trade refuse from the streams to the public sewers would lead to the total drying up of the streams, and this method of purifying the trade refuse in such districts could, therefore, not be entertained. In many cases, however, it will pay the manufacturer to obtain his water supply from wells or from the town's mains, and thus do away with this danger of robbing streams. Any alteration in the law seems scarcely possible, but as there are many districts on the larger streams in which the water drawn from the streams is returned to them within a short distance, and without detriment to any riparian owner between the point of abstraction and the point of returning, it may be a question for the tribunal already mentioned to decide whether it is permissible to divert the trade refuse in such circumstances into the public sewers, but in all cases it would be necessary to leave any riparian owner the right of claiming compensation for actual loss or damage.

14051.* Do you find that the admixture of trade refuse materially increases the difficulty of treating the sewage; apart that is from necessitating an increase in the size of the works ?—There is no doubt that the admixture of trade refuse with sewage does materially increase the difficulty of treating the sewage, speaking generally, and it is likely to be so even if reasonable preliminary treatment has been exacted of the manufacturer. There must be the difficulty arising from the increased volume of sewage, but there is also generally speaking a difficulty arising from the nature of the trade refuse. It is, however, certain from the experience of many authorities that it is quite possible to treat efficiently mixture of domestic sewage and almost any kind of trade refuse, when the latter is not in too great proportion.

14052.* Do you think a local authority should be empowered to construct sewers for trade refuse alone ?—In certain cases it would be of benefit if the sanitary authority had power to construct special sewers for trade refuse and the question has arisen more than once in the West Riding. In dealing with the general question of the admission of trade refuse to the sewers, the Commission should know that two things are special causes of irritation to the manufacturer at present. Such of them as are at present connected to the public sewers object strongly to being put to the expense of preliminary treatment of their refuse, or of paying any special rate, while their neighbours, it may be in the next street, are exempt from this expense merely because they have happened to have their premises connected to the sewers for a long period. In the second place they feel it a hardship that having constructed purification works of any kind, for the advantage, as they think, of the community, they are immediately rated upon the annual value of those works.

14052. (*Sir Michael Foster.*) In answer to questions 14043 and 14044, Dr. Wilson, you state in your notes that the position and rights of the manufacturers and local authorities under the existing law are clearly defined, and that there is no need to alter the law to give manufacturers greater rights than at present. We have had before us a good deal of evidence, rather in the contrary direction, namely, in this way, that the

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present law, at all events as interpreted, throws the onus of obtaining entrance into the drains on the manufacturers to their great disadvantage, and that the proper way of proceeding would be that the manufacturers should have *prima facie* right to enter into the drains, but it should be in the power of the local authority to institute such safeguards as may be thought necessary. That is to say that the Act at present is rather too much in favour of the local authority, and it should be amended so as to give greater power to the manufacturers. You disagree with that ?—Yes, Sir, so far as I can see, it is the present state of the law, that the manufacturer can claim to discharge his refuse into a public sewer, and provided his refuse will not interfere with the treatment of the sewage with which it is mixed, and provided the sewers are large enough the authority is bound to take his refuse. It seems to me nothing could be much clearer than the present state of the law in the matter.

14053. We have evidence to the contrary. A witness just now stated that, for instance, in the River Pollution Act, Section 7, the words, "Shall give facilities," did not really compel the local authority to take the manufacturer's refuse under any conditions whatever ?—I do not think, Sir, that is the generally accepted meaning of that Act. Of course, I cannot give you a legal opinion.

14054. It is a question of experience. Your experience is that it is sufficient ?—Yes ; I do not know of any case in which it has been regularly tested in the Courts ; I do not think there has been such a case.

14055. (*Colonel Harding.*) As a fact, Dr. Wilson, there is really a deadlock in the work of the Rivers Board, owing to the condition of the law largely, is there not ? What I mean is this : here is what you consider, you told us just now, to be a sufficiently definite statement of obligation on the part of the local authorities, but in fact no decision can be come to between the local authority and the manufacturers in a great many cases at all. The local authority is able indefinitely to postpone a decision, and to ride off on one or other of the provisos of the Rivers Pollution Act ?—That is so, Sir, but that is another matter. The local authority, although in almost all cases feeling themselves bound to take the trade refuse, do ride off on the provisos, and in laying down conditions upon which the manufacturers will be allowed to connect to a sewer, make them sometimes so stringent that the manufacturer does not wish to avail himself of the privilege.

14056. Well, now what the Commissioners want from you is your opinion as to how the present condition of things can be improved. We find now in practice, do we not, that indefinite delays do arise in these conferences between the manufacturer and the authorities, and that in consequence of these indefinite delays, the work of the Rivers Board has been very greatly interfered with. Do you suggest to us that no alteration in the law is required? —I do not really see that much alteration, or any, is required. The chief stumbling block in the way is this : take, for instance, the case of the manufacturers in Halifax. There are roughly speaking three-fourths of the manufacturers now discharging into the sewers, without any preliminary treatment of their trade refuse whatever. The other fourth discharge into the stream, and the Rivers Board has pressed them for the purification of their trade refuse, but has delayed taking the matter to extremes, because the Corporation have said they are willing to receive the trade refuse into the sewers, only on condition that the manufacturers will put down works for the preliminary treatment of their trade refuse,as I think has been explained to you by the Halifax representatives. But these manufacturers object—very strongly object—to being obliged to carry out any such works for the preliminary treatment of their refuse, because their neighbours are doing nothing, are discharging into the sewers without any treatment, so that it is not so much there an alteration of the law as regards the admission of new trade pollutions into the public sewers that is required, as an alteration in the direction of making the law equal for those who are already connected with the public sewers. But the Corporation is, and generally speaking, in the West Riding, public bodies are not averse, do not refuse to take trade refuse into the public sewers, but will take it upon conditions of certain preliminary treatment.

14057. Are we to take it that you feel that it would be difficult to modify the law so as to make it definitely applicable to all classes. You think that ultimately it must be matter of bargain between the authority and the manufacturer ?—Yes ; but I think very strongly that the manufacturer will feel aggrieved, and justly so, if the law is not made applicable to cases of old connections, as well as to all cases of new connections.

14058. Then the question of prescription crops up, does it not ?—Yes.

14059–60. And that is somewhat difficult to deal with, may be ?—It may be. That could only be dealt with by an alteration of the law. That seems to be the chief point in which the law requires alteration.

14061. Would you throw upon the local authorities the obligation within a reasonable time to give their decision as to whether they will or will not receive trade effluents ; would an alteration in the law in that direction be useful ?—I do not see that it would, Sir. Of course, the present position of matters is that the Rivers Board is the authority which has the duty of seeing that the decision is given within a certain time by pressing the manufacturers.

14062. Is the pressure effective ?—Yes ; the action is very slow, as you are aware, Sir, but it is effective in the end, and we have in most cases now got a decision from the authorities as to the conditions upon which they will accept trade refuse.

14063. Are there not, in fact, many cases before your Board where this question has been hanging over for several years and correspondence has been taking place between the Board and the manufacturers and the local authority, and yet no decision is arrived at ?—I think there is no case where no decision has been arrived at, but in certain districts the authorities have stated that it is not their intention to take their refuse into the public sewers.

14064. Well, does that settle the matter, are you then able to compel the manufacturer to purify his effluents so as to make them fit to go into the stream ? —The Board can only deal with the manufacturer. That point would not require an alteration in the law, for there it would rest with the manufacturer to put in force the present law, which has never been tested, to compel the authority to take his trade refuse.

14065. You say that has never been tested ?—It has never been tested to my knowledge.

14066. The point in the well-known Peebles case was the obligation on the authority to put in a sewer large enough to take a trade effluent ; that was the point in the Peebles case, was it not ?—Yes, that is so, Sir.

14067. Then you say this point has not been tested as to whether there is an obligation at all on the authority to take a trade effluent if the sewer is large enough ?—Not to my knowledge.

14068. Would it be useful in the general interests of manufacturers and authorities that such a case should be set before the Courts ?—It would be very important indeed, and the Rivers Board has in several cases, although perhaps not officially, urged the Association of Manufacturers in the West Riding to take up that very point, and they undertook to do so some two or three years ago, but they have not yet taken it.

14069. I think we have heard some suggestions from the manufacturers that the Rivers Board themselves should take a test case ?—It is not possible ; we have no power to take a case of that kind.

14070. Then the only bodies which would be in a position to take such action would be either a very wealthy firm of manufacturers or an association of manufacturers ?—That would be so.

14071. And you think it would be of great utility if a definite case were brought so as to settle once for all whether the local authority was obliged to take any trade effluents if the sewer was large enough ?—It would make that point quite clear.

14072. (*Sir William Ramsay.*) But I thought it had already been decided that a larger sewer should be put down ?—I think, Sir, the Peebles *v.* Oswaldtwistle Urban District Council case is somewhat confusing. According to my recollection, Mr. Justice Charles decided that the authority was bound to put in a sewer specially to take

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this refuse from a papermaker's. The case was appealed, but the appeal was not decided upon that ground at all, but upon the method of procedure. It was said, I think, that the proper Court of Appeal was the Local Government Board, that the appeal should in the first instance have been taken to the Local Government Board; at least the main point was not decided on appeal.

14073. (*Colonel Harding.*) As a fact, an appeal was made to the Local Government Board, was it not?—Yes.

14074. And what was the result of the appeal?—I am sorry I do not know very definitely. I think that Peebles has put in special purification works of his own and now discharges to the stream.

14075. I believe the manufacturer did appeal to the Local Government Board and the Board declined to make an order on the ground that the local authority were under no obligation to provide sewers for trade effluents?—I am not aware.

14076. I am told that that is so?—I might mention a similar——

14077. So that you say the law is still indefinite on that point?—I might mention a similar case which might be of assistance to you. I have mentioned it in this paper, "The Admission of Trade Waste to Sewers," page 2: "In the case of the complaint of Messrs. Mallalien to the Local Government Board, under Section 299 of the Public Health Act of 1875, that the Saddleworth Urban District Council had made default in that they had not provided sewers sufficient to take Messrs. Mallalien's trade refuse, the Local Government Board held, after enquiry (21st June 1898), that the Sanitary Authority had not made default, implying that they did not consider it the duty of the Authority to make their sewers large enough to take the trade refuse of their district."

14078. Or in other words they were not obliged to make the sewers large enough to take this man's effluent?—That is so, and on the other hand you will find on the same page I have quoted from the proceedings of the Commission: "The Scotch Local Government Board are advised by their legal advisers that the sanitary authority must make new sewers large enough to take the trade refuse."

14079. Then evidently there is considerable uncertainty as to the interpretation of the existing law?—That is so, Sir, but it is the interpretation that is wanted and not an alteration in the law.

14080. You take it that it is desirable, if possible, that it should be made clear either by an alteration in the law or by the carrying out of a distinct test case?—Certainly.

14081. It has been suggested to us this morning and on previous occasions by manufacturers that the law should be altered, that it would be convenient that it should be altered in this direction, to specifically lay an obligation upon the local authority to receive trade effluents, giving them, however, power to make conditions, but throwing upon the authority the onus of showing that a particular effluent was noxious and that in that case certain preliminary treatment was necessary. You follow me, do you not?—Yes, quite.

14082. That has been suggested to us, and that then if there was disagreement between the two parties there should be some speedy and inexpensive Court of Appeal. Now, do you think yourself that it would be useful for the Commission to suggest that the law should be altered in that way? It would appear, on the face of it, of course, to be against the local authority, but if there was power of appeal to some other body then a case would everywhere be considered on its merits. What do you think of it?—That is a suggestion that has been made to us? I think that would bear rather heavily upon certain local authorities. Take, for instance, this very Saddleworth Urban District Council. Before they carried out their scheme of sewerage and sewage disposal—it is quite a new scheme, it has been in operation now about five years—they summoned together the manufacturers in their district and consulted the manufacturers whether the trade refuse of the district should be taken into their new scheme or not. The manufacturers were at that time practically unanimous, and I believe it was settled at that meeting that it was not advisable to take the trade refuse into the sewers, and the sewers were accordingly made of such a size as only to take the domestic sewage of the district. If now the manufacturers, or any number of them, were to have the power to demand that the sanitary authority should take their trade refuse into their sewers, that whole scheme from beginning to end would have to be reconstructed, the sewers would have to be replaced by very much larger sewers, and the sewage works, of course, would have to be very much enlarged.

14083. One appreciates, of course, that cases will vary very much, but if the obligation were thrown upon the authority to receive trade effluents and the onus of showing why they did not receive them, and an appeal from that, it would bring about in each case a careful consideration of the special circumstances by some appealing body, would it not?—It would, Sir, but I think, as far as I can understand the present law, that is the case at present; that the authority, except for these provisos in the Acts, are bound to take the trade effluents of the manufacturers if they demand it, and there is an appeal to the Courts.

14084. But we find in practice now that the law is not clear on the subject, that it is not clear that an authority is to provide sewers large enough; that is not clear, is it?—No, Sir, that point has not been decided.

14085. And you tell us that a test case on the others has never been brought as to the mere liability?—That is so.

14086. Well, then, the condition of the law is as yet uncertain?—On these two points.

14087. (*Sir Michael Foster.*) But one is the main point whether the local authority is bound.

14088. (*Colonel Harding.*) And you say, if it is bound, it is only bound if the sewer is large enough, and both of those points are uncertain?—These are points I would prefer your getting the opinion of legal experts on, because it seems to me the reading of the Act is perfectly clear. I see no doubt in the Act at all. It says the sanitary authority shall offer facilities provided certain things take place. There is no hesitation about the law at all.

14089. Are we to take it that in your opinion an alteration of the law is not necessary, that the law is clear enough now?—I think so, Sir, unless these cases were decided in the opposite meaning. A test case wants to be taken; it wants to be cleared up in that way more by testing the present law, which has never been done in my knowledge, than by altering the law.

14090. (*Sir William Ramsay.*) The words might be altered, instead of "offering facilities for the admission of trade refuse," "shall admit trade refuse." That would be absolutely unambiguous?—I do not see what difference it would make in practice. It would have to be decided again as to the provisos

14091. (*Colonel Harding.*) Your own opinion clearly is that power should be given to a local authority to make conditions before the local authority is bound to receive trade effluents?—Certainly.

14092. Reasonable conditions?—Yes.

14093. Of course, it may be a matter of appeal as to whether the reasons are reasonable or unreasonable?—Yes.

14094. You think the size of the sewers ought to be taken into account, and that they ought not to be put to manifest expense to meet the case of a manufacturer, who possibly has land upon which he could himself treat his trade effluent?—Certainly.

14095. That all these cases would have to be carefully considered, but after all what is wanted, is it not, is a general clear statement of law bearing upon the matter which would give to the authorities and to the manufacturers a power of discussion, and in the event of inability to come to agreement to appeal to somebody outside. Do you not think that is what is required?—That is the main thing, Sir, more than an alteration of the law. Perhaps, it supposes an alteration of the law, but instead of these cases being taken to the law courts for decision, if the authority and the manu-

facturer cannot agree upon the conditions, they should be taken to some more direct and more expert tribunal.

14096. Would it, in your opinion, be an advantage that there should be laid on the local authority a distinct obligation to receive trade effluents, subject to their giving reasons why they did not wish to receive it?—Yes.

14097. Subject to their giving conditions antecedent to their receiving it?—Certainly, simply from the point of view of the purification of the rivers it would be a very good thing if the larger number of the trade pollutions could be received into the public sewers, and dealt with along with the domestic sewage.

14098. Then if the law could be so altered as to lay a more definite obligation than there seems to be at present on the local authority, do you think that would be an advantage?—Yes.

14099. Subject always to their having a power of appeal?—Yes, certainly.

14100. If your colleague on the Mersey and Irwell Board, Mr. Tatton, says that he thinks a definite obligation of that kind would be desirable, do you agree with him or disagree with him?—The distinct obligation for the Sanitary Authority to take the trade refuse?

14101–2. Yes; subject to their having power to make conditions?—Yes.

14103. And subject to their having power of appeal on either side?—I agree with him.

14104. Now as to the body to appeal to, do you consider the ordinary Courts, as the rights now exist of appeal, would suffice, or would you suggest that some speedier and less expensive course should be available?—Oh, I think a much speedier and much less expensive course should be available. Our experience of law appeals is not very good, I think, in West Yorkshire. There is the case of Eastwood v. Honley somewhat dealing with these points, where a manufacturer had for a number of years been discharging into the sewer, and the Sanitary Authority wished to cut him off. These proceedings took, I think, about fifteen months to carry through to the Appeal Courts. It is obvious that a very much more speedy appeal than that, and a much less costly appeal would be of advantage both to Sanitary Authorities and to manufacturers.

14105. Well, you have considerable experience in the West Riding Yorkshire Rivers Board; do you think from your experience that such a Rivers Board could be a sort of first appeal court, which would meet with general confidence by manufacturers and local authorities. I do not mean a final appeal court, but a first appeal court?—I think so. I think, generally speaking, both authorities and manufacturers would recognise the Rivers Board as unbiassed. I see you have had evidence from one manufacturer that the Rivers Board would be biassed in favour of the Sanitary Authorities, and from another that they would be biassed in favour of the manufacturers, so that between the two I think is a proper view.

14106. You think from your experience that as a court of first appeal it would command the confidence of both parties?—I think so.

14107. Then from that body do you think it would be well to have an appeal, say, to the Local Government Board or some special central board, constituted for the specific purpose of Rivers Pollution prevention?—Yes, either would, I think, meet with the confidence of both the Sanitary Authorities and the manufacturers.

14108. It is the fact that there is a great deal of complaint of delay in connection with appeals to the Local Government Board, and the inquiries which they institute?—There is so. Of course, I am supposing that these appeals would be dealt with promptly; it would be better, as the Commission has already suggested that a special tribunal, a special central Rivers Board Authority, should be constituted, before whom these appeals would come.

14109. And you think that if some speedy and inexpensive method of appeal could be introduced by law that that would be warmly welcomed by both the authorities and the manufacturers?—I believe so; I may say, in connection with your speaking of the Rivers Board being the first board of appeal, that frequently both authorities and manufacturers have asked me to intervene, although they knew that it was unofficially, in the case of a manufacturer having to put down works for the preliminary treatment of his trade refuse. In several districts they have asked me to meet them, the Sanitary Authorities' representatives and the manufacturers, on the spot, to discuss what the manufacturer should do for the preliminary treatment of his sewage.

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14110. And have you been able to bring them to a decision?—Yes, in many cases.

14111. (*Mr. Power.*) And both parties have practically accepted your decision?—Yes.

14112. (*Chairman.*) Did I understand you to say that you consider all manufacturers should be put on the same footing; that one manufacturer, because he has got prescriptive rights, should not be allowed to have any advantage over another manufacturer who is starting afresh?—Yes, I think so, because it is a source of great irritation amongst the manufacturers who now wish to be connected to the sewers that they are compelled to go to considerable expense it may be, whereas their neighbours, simply because they have happened many years ago to be connected to a public sewer, have not to go to the same expense.

14113. Then you think there ought either to be a levelling up or a levelling down?—Yes, they ought to be placed on the same footing.

14114. All manufacturers should be put on the same footing?—All manufacturers should be put on the same footing; that is what they are continually asking.

14115. (*Colonel Harding.*) In regard to the difficulties in the way of dealing with prescriptive rights, is it really a serious difficulty at all between these manufacturers that they should be equal; are there not many other conditions of inequality between them; for instance, that a man has had the good fortune to buy land twenty years ago, when it was fairly cheap, and, therefore, he is placed in a better position than a neighbouring manufacturer who, coming on the spot at the last moment, has had to pay three or four times the value of the land?—I do not think they would feel that an inequality so much as the other. The other is the method in which the Sanitary Authority deals with them, the Sanitary Authority which they support by rates, and they do feel it, I assure the Commission, a very serious grievance that they are dealt with on a different footing.

14116. (*Mr. Power.*) They are, are they not, one-fourth of the whole, in the area of which you are speaking; those that would be connected with the sewers would be about one-fourth?—I was speaking of Halifax.

14117. (*Major-General Carey.*) Have the manufacturers who claim prescriptive rights to be admitted into the sewers connected their drains conveying the trade refuse with the formal consent of the local authority, or have they been connected surreptitiously?—I should think in most cases it is old history; that no one knows how the connection was made, but the sanitary authority must be taken to know that the trade refuse has been flowing into their sewers for a large number of years in nearly all the cases. There are cases of surreptitious connection certainly.

14118. It would be easier of course for the local authority to insist upon trade refuse being taken out if necessary and treated in some way before entering the sewers if the drains had been connected without their knowledge or consent?—Oh, yes; I may tell the Commission of one very peculiar case in which we were pressing a manufacturer, a wool comber, to deal with his trade refuse, which was then going into a stream. He immediately pumped it into his water-closet, and got rid of it in that way.

14119. (*Chairman.*) Do you know the provisions of the recent Act at Bradford?—The Act of 1897, my lord?

14120. Yes?—Yes; I prepared evidence for the Corporation.

14121. Because is it not the case there that the local authorities had to buy out the prescriptive rights of the manufacturers?—Yes; I think they made a great mistake there. They did insert in their Bill a clause stating that each wool-comber of a specified number of wool-combers was to be paid so much per comb and

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after that he was to be called upon to deal with his refuse by preliminary treatment before discharging into the sewers, but only these specified wool-combers.

14122. (*Colonel Harding.*) And the Act has been a dead letter ?—The Act has been a dead letter.

14123. Have the powers under the Act expired ?—No, they do not expire.

14124. So that the Corporation could even now pay these moneys, and so obtain control ?—Yes, they could.

14125. So far as you know there is no intention to do it ?—I have heard the Chairman, Mr. Johnson, who appeared before you, say that it was not their intention ; they knew now that they had made a mistake in that. I think I should say that that is another point upon which the law is not quite clear, whether in the case of a manufacturer discharging for a prescriptive period into the public sewers the sanitary authority can call upon him to deal with his refuse by preliminary treatment. In many of those cases in Bradford, for instance, the sewage, after being mixed with the trade refuse, has been up to the present very imperfectly treated, and it was not a great matter to the Corporation whether the manufacturer was treating his refuse before he turned it into the sewer or not. Now when they have to go to the expense of a complete scheme for dealing with their sewage it is quite a question whether they can call upon the manufacturer, apart from this payment mentioned in their Act of 1897, to deal with his refuse by preliminary treatment, in cases where he has been discharging for twenty or thirty years into the sewer.

14126. (*Sir Michael Foster.*) That is to say you think that the local authorities should have the right in such cases ?—Yes.

14127. Where a demand is made upon them for extra expense in treating their sewage in a way different from what they did before ?—Yes.

14128. In that case, since the trade refuse is a great obstacle to that treatment, then in spite of prescriptive rights they should have the power to charge the manufacturer or to compel him to take certain steps ?—Yes ; and if the law is not sufficient to empower them to do so it should be altered in that respect.

14129. (*Dr. Burn Russell.*) You would think it very desirable that the expression of the law should be such that the occasions for the test cases should be as few as possible ?—Oh, certainly ; it should be as clear as it is possible to make it.

14130. It would be apt to be an injustice as regards small businesses which cannot face the large expenditure ?—That is so ; a small manufacturer would hesitate, in fact, would not take proceedings against a large corporation in the present state of the law, it is so expensive for him ; he would rather put up with what he considers injustice than go to the expense of very costly legal proceedings. There is one letter that I promised to put before you in connection with the injustice some of your witnesses have complained of in the rating of purification works. Messrs. Fisher, Firth, and Co., Cellars Clough Mill, Marsden, near Huddersfield, in the first place complained to the Rivers Board, and I informed my Committee I would put the matter before you. The letter is as follows :—

"October 2nd, 1902.

"The West Riding Rivers Board,
"Wakefield.

"Gentlemen,

"Will you permit us to point out a matter that seems to us a great injustice to anyone putting down a plant for the treatment of their trade refuse waters? Hitherto after purification works have been put down the rating authorities have pounced on to them and rated them, and as we think it is now admitted on all hands that any works for the purification of trade waters means a loss to those people putting them down, such works ought not under the circumstances to be further taxed by having to pay rates. We think that if your Board took the matter up with the rating authorities that they would see the force of the argument, and if they would refrain from rating them in future there can be no doubt that it would assist in the purification of the trade waters generally throughout the whole district.

"We are, Gentlemen,
"Yours respectfully,
"Fisher, Firth, and Co."

The Committee and the Rivers Board considered this letter, but resolved that they had no power to deal with the matter at all, and as I informed them I was appearing before you to-day I informed them I would put the matter before you.

14131. (*Sir William Ramsay.*) The sewage works are rated too ?—Yes, they are rated too.

14132. (*Colonel Harding.*) Surely it is a very small matter ; supposing the man spends £500, what would be the average rate in the West Riding towns on that outlay : something quite trifling ?—It would not be a large amount.

14133. Well, it would be a matter of shillings ?—It would be a matter of pounds ; it would come to some pounds, would it not ; he might be rated at £50 a year.

14134. What, on a capital outlay of £500 ; he would not be rated at £50 a year, would he, 10 per cent. ?—I must say I do not know how these works are rated. Then I have, if you wish it, an analysis of the sample that Mr. Butterworth placed before you.

14135. Mr. Butterworth was the manufacturer who said that he had obtained excellent results by his process, results that satisfied you ?—Yes.

14136. Only he complained that the cost for bringing them about was somewhat too high ?—That was so.

14137. He was unable to give us the analysis, and I think through our Secretary we asked you to give us them ?—Yes.

14138. Will you please give us them ?—The result is very good indeed.

WEST RIDING RIVERS BOARD.
Chief Inspector's Department,
Wakefield, 4th June, 1902.

Sample of effluent passing to stream from D. Butterworth and Co., per Royal Commission on Sewage.

Date and hour when taken, April, 1902.

Taken by firm ; received, 28th May, 1902.

Physical characteristics :—

Liquid, bright and clear.
Sediment, very small grey.
Odour, none.
Reaction, neutral.

Result of analysis in parts per 100,000 :—

Solids in solution, 53·0.
Solids in solution, loss on ignition, 3·0.
Solids in solution, ash, 50·0.
Ammoniacal nitrogen, from free and saline ammonia, trace.
Albuminoid nitrogen (*Wanklyn*), 0·014.
Oxygen absorbed in 4 hours at 26·7°C, 0·34.
Hardness (in terms $CaCO_3$)—total, 7·5.
Hardness (in terms $CaCO_3$)—permanent, 4·0.
Hardness (in terms $CaCO_3$)—temporary, 3·5.
Total iron and alumina salts as oxides, 0·40.
Total calcium salts as $CaCO_3$, 4·8.
Total magnesium salts, trace.

Remarks—A good effluent.

EDWARD HALLIWELL,
For H. Maclean Wilson, M.D.

FORTY-EIGHTH DAY.

Thursday, 16*th October*, 1902.

PRESENT :

The Right Hon. The EARL OF IDDESLEIGH (*Chairman*), presiding.

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P.
Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Colonel T. W. HARDING.
Dr. JAMES BURN RUSSELL.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary*.

W. WILLIAMS, M.A., M.D., Ch.B., D.P.H. (Oxon.), M.R.C.S., F.C.S., etc., Medical Officer of Health to the Glamorgan County Council, called in and Examined.

W. Williams, M.A., M.D., CH.B., D.P.H. (Oxon.), M.R.C.S., F.C.S., &c.

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14139. (*Chairman.*) You hand in this paper chiefly on coal washings and effluents from tinplate works which your experience in Glamorganshire has enabled you to prepare?—I was appointed Medical Officer of Health to the Glamorgan County Council in 1892, and for some time previous to that date I acted as Assistant and Deputy Medical Officer of Health for Shropshire. On the 21st June, 1901, I had the pleasure of giving evidence before the Royal Commission on Sewage Disposal, and on that occasion I dealt chiefly with the discharge of sewage and sewage effluents into *tidal rivers, estuaries, and the sea.*

On the present occasion I understand that the Commission are taking evidence on "the relative position of manufacturers and local authorities as to the disposal of trade refuse," but that witnesses are not limited to the list of questions submitted to them, should there be any cognate questions on which they would like to speak. It is, therefore, my intention to confine my remarks chiefly to coal washings from collieries, and the disposal of effluents from tinplate works, of which there are many in South Wales, especially in Glamorgan. The Sanitary Committee of the Glamorgan County Council have taken up the question of the purification of rivers with great energy during recent years throughout the whole county, which had a population at the last census of 601,087. Although the County Council has been instrumental in reducing the pollution of the rivers by sewage and trade effluents to a great extent, yet they felt that more good work could still be accomplished in this direction, and, acting upon my advice, in December, 1901, a County Sanitary Inspector was appointed, whose duties amongst others are as follows :—

1. To regularly visit, inspect, and report on the sewage works of sanitary authorities, colliery, tinplate and other works, and all rivers within the administrative county.

2. To take samples for analysis. in all parts of the county, of drinking water, effluents from bacterial tanks, sewage farms, trade effluents, river waters, &c.

3. To attend Court and give evidence in case of prosecutions instituted.

It should be stated that in the whole county there are 30 sanitary districts, and out of these 13, representing a population of some 516,000, discharge their crude sewage into *tidal rivers, estuaries, and the sea*, and the sewage of some nine districts or parts thereof are treated on sewage farms, of which there are several arge and small in the county.

With a view of being able to furnish the Commission with information regarding the admission of trade refuse into sewers, I addressed a circular letter to all the sanitary authorities in the county, and have received answers from the majority of them.

After carefully perusing the answers received, and having regard to the fact that the chief industries carried on in this county are those connected with coal-mining and tinplate manufacturing, I have decided to confine my attention to these, indeed, there are but few other industries carried on to any great extent, with the exception of some few chemical works, a large number of breweries, and a few offensive trades.

The majority of the chemical works are confined to two localities on the sea-shore, and in no instance are the effluents therefrom admitted into the sewers.

Brewery Wastes (liquid) are generally admitted into sewers, and, as I am informed, without any injurious effect.

Offensive Trades.—The liquid refuse from these trades is generally admitted into sewers after the removal of all grease and suspended matter.

With regard to the admission of coal washings into sewers, this is not allowed in any instance, although it is impossible to exclude it entirely. It is guarded against in many places by settling tanks, in which the finer particles of coal are allowed to deposit, which deposit is afterwards converted into coke or otherwise made use of.

In connection with the majority of our collieries settling tanks are still needed and those that are in existence require more attention than they receive, with the consequence that some of our rivers contain a large quantity of small coal in suspension, rendering them almost black, and great difficulty has been and is still experienced in Glamorgan in endeavouring to prevent the admission of small coal into rivers, and I consider that coal-washing should be brought within the provisions of the Rivers Pollution Acts, so as to compel colliery proprietors to erect the necessary settling tanks.

Tinplate Manufacture. — After the raw material called tinplate bars have been heated, rolled, sheared, opened, the resulting plates are then placed in a cage containing racks in which they are stacked. The cradle or cage and contents, is then immersed into a tank containing crude oil of vitriol, then the cage is raised and again immersed, and so on until the surface of the plates is cleansed from all scruff, &c. This process is called "pickling." The acid used in time becomes "spent" and is then run out of the tanks.

There are two general methods adopted in dealing with the waste "pickle." The first and best method is to pass it into a lead-lined tank at the bottom of which there are coils of lead steam pipes, through which steam passes day and night, the object of which is to cause the evaporation of the excess of water, and thus concentrate the liquid ; scrap iron is added and a solution of sulphate of iron is formed ; this solution is then turned into other lead-lined tanks, in which are also placed scrap iron and pieces of lead or wood to which the copperas crystals adhere. The mother liquor which remains in these tanks is drained off into a lead-lined well, from which it is again pumped back into the boiling tank, and after being concentrated and mixed with more pickle, once more finds its way into the crystallising tanks. If this method is carried out in properly-constructed lead-lined tanks supported on brick piers, on a cement concrete foundation, the difficulty of dealing with the "pickle" is overcome. The objections urged by manufacturers are :—

(*a*) First cost of the copperas plant.

(*b*) That the manufacture of copperas does not pay.

There can be no doubt, however, that when properly carried out the manufacture of copperas is usually a source of some profit to the maker.

There are some 40 tinplate works in the County of Glamorgan and a few at present idle. Of these, eight are situated on the sea shore, 10 on tidal rivers, and 22 on non-tidal rivers.

At two of these works "black plate" alone is produced, and therefore no acids are used. At the remaining

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works, crude vitriol is used, and the pickle is converted into copperas. In several cases the copperas tanks, &c., are out of repair, allowing considerable soakage and consequent pollution of adjoining stream and rivers; frequent examinations of these premises are therefore essential.

The three works at which copperas is not made are situated quite inland and on the same river, namely, the Taff, once well known as a fishing river.

At one of these works the "pickle" is pumped on to large cinder heaps, which are always present in the vicinity of these works. The acid is spent by coming into contact with the iron in the cinders. The sulphate of iron produced may, however, be dissolved by surface water and carried in solution to the adjoining river, and, although the effluent thus produced is not seldom found discharging through any particular channel, yet the chemical analyses of samples taken from adjoining streams and rivers are often found to contain *free acid* and *sulphate of iron*, as is shewn to be actually the case, thus :—

ANALYSIS OF TINPLATE EFFLUENTS.

Results stated in parts per hundred thousand.

No.	Date collected.	Acidity (free sulphuric acid).	Fe
1.	April 23rd, 1902	0·98	28·5
2.	June 13th, 1902	2·4	28·9

I am of opinion that the conversion of the "pickle" into copperas, wherever the works are situated, should be insisted upon, and that facilities should be given at all reasonable times for the taking of samples and inspection of the works by persons employed by County Council and local authorities. With regard to the latter my experience is that they but seldom take any samples or inspect these works; on the other hand, some local authorities in Glamorgan are in the habit of occasionally inspecting these works and reporting thereon to me.

(*Swilling Fluid.*)—The swilling fluid is very much weaker than the pickle, but in volume very much larger, and to get rid of the free acid and sulphate of iron it contains is a difficult problem.

The analysis of two samples of the swilling fluid taken as it leaves the tanks is given below.

No.	Date collected.	Acidity (free sulphuric acid.)	$FeSO_4$
1.	March 19th, 1902	168·5	334·4
2.	March 26th, 1902	41·1	574·5

It is only in one instance that any attempt is being made to purify the swilling fluid. In this case the effluent is made to pass through several sets of limestone bays, the action being partly mechanical and partly chemical, producing oxide of iron and sulphate of calcium which are deposited. No doubt some purification results from this method, but in practice it is found that the limestone becomes coated with a yellow deposit and the action of the acid upon them ceases.

The broken limestone should be frequently changed and washed, and if this is not done the deposit on these prevents further action. The water in this river below the works is used for drinking purposes by animals.

Whether the "Swilling Fluid" should be treated or not depends upon circumstances existing in connection with the works such as :—

(*a*) The situation of the works, and

(*b*) The uses made of the river's water below the works.

1. If the works are on the sea, and *not* near the estuary of an important river, as some are, then there would be no need of purifying the effluent.

2. When the works are situated on estuaries containing *large volume* of water, there would under these circumstances be no need of purifying the effluent.

3. When the works are situated on tidal rivers, it may or it may not be considered necessary to purify the effluent. This would depend on the quantity of water contained at various seasons in the river at the point where the effluent is discharged, and whether the river's water would by the admission of the effluent be rendered inimical to fish life.

In Glamorgan, all works on tidal rivers discharge the swilling effluents untreated into the adjoining rivers.

4. When the works are situated inland on non-tidal rivers, as the greater number of our works are in Glamorgan, matters are different, and here the great difficulty arises.

Here again local circumstances must be taken into consideration, such as the volume of water in the river in the dry seasons, and whether the river's water is used for drinking purposes by man or animals, or otherwise made use of below the works.

At one tinplate works in Glamorgan the "swilling effluent" is treated as above described, and preparations are being made at two other works to treat the effluent in a similar manner.

14140–14141. You say that the work of the Sanitary Committee of the Glamorgan County Council has been successful; now do you consider that the success is as great as could have been hoped for?—No, I do not, my lord. It has been successful in particular with regard to sewage, but not as far as there could have been wished in regard to trade effluents, that is effluents from collieries and effluents from tinplate works.

14142. Is there good reason to hope that as time goes on their efforts will become more successful?—There may be, perhaps, but we continually find obstacles in the way; for instance, some years ago the Glamorgan County Council took proceedings against a colliery company for polluting the river with coal washings and small coal the case failed because we were told it was not a pollution, so I am afraid not so much progress as could have been wished will take place in that direction. With regard to tinplate works the Council have been pretty successful in persuading, not in compelling, the owners to put up the proper plant for converting the pickle into copperas, but in that direction, too, we hope to have better results as time goes on.

14143. Well, then, I want to ask you, are you of opinion that coal washings ought to be brought within the provisions of the Rivers Pollution Prevention Act?—I am decidedly of that opinion, my lord, although the County Council of Glamorgan, have been successful for the last 10 years or so in reducing the pollution of rivers by sewage, they are now, some of them, very black indeed, and although there is not very much coal dust in some of them, the people will have it because they are black they are polluted with sewage and that they smell. There is no doubt about that, that in the case which we tried already we failed and no proceedings afterwards have been taken.

14144. (*Sir Michael Foster.*) They are black from the coal in suspension?—Yes; from the coal in suspension.

14145. (*Sir William Ramsay.*) I suppose it is not very encouraging for the Boroughs to keep their sewage out of black rivers; the rivers look polluted already?—No; quite so. The rivers look polluted already; they are black already, but they are not so polluted now as they were 10 years ago by any means.

14146. (*Sir Michael Foster.*) That has of course a very prejudicial effect upon the fish, has it not, the suspended coal?—Well, I cannot speak with regard to fish with any authority, but it is a fact that fish have disappeared from our rivers. They used to be there many years ago, I am told.

14147. You cannot speak with any knowledge?—I cannot speak with any knowledge, no.

14148. The coal being suspended mechanically interferes with the respiration of fishes?—In all probability, but I cannot speak with personal knowledge.

14149. Does it otherwise change the character of the water; have you any knowledge as to the character of the water after you have removed the suspended coal; can you filter it quite clear?—You can filter it quite clear.

14150. Then has it a normal quantity of oxygen?—That I cannot say.

14151. So that the effect of the coal in suspension is purely mechanical?—Purely mechanical action, I think, and in those instances where settling tanks should have been put up, after the sedimentation has taken place the water is used over and over again and none of the water need go into the river at all. It is very successful where they have been put up, and I am told a source of income to the owners. I could not give you figures for that.

14152. Then your view is that the coal washings should be regarded as a pollution of the river and the coal owners compelled to use a filter?—That is my opinion.

14153. (*Sir William Ramsay.*) Is there always room for settling tanks?—In our county, yes, I should think so in all cases; of course, they are up in the country all these collieries.

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14154. (*Sir Michael Foster.*) It takes a long time the settling, does it not?—It takes a long time.

14155. More than twenty-four hours?—Well, no, I do not think it would take longer than that to remove a great part of it. Then you can use the water over again.

14156. I see, with the removal of the larger part of suspended coal the water is brought in to such a condition that it may be used over again?—For washing purposes.

14157. (*Sir William Ramsay.*) And is the precipitate of coal, of commercial value?—So I am told.

14158. (*Sir Michael Foster.*) You have no actual facts as regards that?—No; no actual facts as regards that.

14159. If it were of commercial value and would repay them, why should they refuse to put them up?—Quite so; I suppose it would be the initial cost they would object to. As some of the works at which these tanks have been put up, I have been told that they do pay. The same again with the tinplate works; it is the initial cost that the manufacturers object to.

14160. (*Colonel Harding.*) You tell us that you would like to see brought within the Rivers Pollution Act the passing of coal into the rivers, but have you been advised by your legal adviser that you have not already powers under that Act in reference to coal dust?—I have not been advised, no; I have cited a case where proceedings failed.

14161. Notice in connection with Part I., the law as to solid matters, it says that the solid refuse of any manufactory, manufacturing process or quarry, or any rubbish or cinders, or any other waste?

14162. I can only tell you that in the West Riding of Yorkshire the evil connected with the passing of coal dust into the rivers has completely ceased by the action of the Rivers Boards?—Quite so, sir.

14163. And all the coal-washing people have put down the necessary plant, and that source of pollution has almost entirely ceased?—Have they not, sir, these powers under a special Act of Parliament, I think that is so.

14164. You may be possibly right in supposing that?—I am under that impression.

14165. That the West Riding Rivers Boards Act gives them special powers?—That is so.

14166. But it would be worth your while, I think, to enquire from Dr. Wilson, the chief officer of that body what has been done in the West Riding of Yorkshire because you will find that that one has now entirely ceased there, and that the colliery owners have found it worth their while to put down the necessary plant, and in most cases it is as you say that the water is so cleansed that they can use it over and over again, so that in fact the effluent itself ceases to pass into the river; the water is used over and over again?—This I will do.

14167. Therefore what has been accomplished it appears to me in Yorkshire, and I have reason to think also—Dr. Burn Russell will probably ask you a question—in Scotland, ought to be possible in Wales?—Quite so.

(*Sir Michael Foster.*) What Act was that you were quoting?

(*Col. Harding.*) The Rivers Pollution Prevention Act, Part I., solid matters.

14168. (*Sir Michael Foster.*) Do you know, is arsenic ever present in a pickling fluid; has it been looked for?—It has not been looked for so far as I am aware. That is a point we could easily inquire into.

14169. You say now you cannot compel these manufacturers to treat their pickle?—No, sir.

14170. (*Col. Harding.*) Manufacturers in the West Riding are compelled to treat their pickle?—I do not think that they have any in the West Riding of the class that I am referring to here.

14171. Well, most of them have the advantage of being able to get into the sewers?—Yes, quite so. Well, none of ours could get into the sewers at all; they are all out in rural districts without any sewer near to the majority of them.

14172. Then in regard to the passage of such effluents into the rivers, have you no powers? You have powers, have you not, against the passage of these iron waters into the rivers; can you not get the people to put down the plant?—We have persuaded most of our manufacturers to put down plant to convert the pickle into copperas, but in a case about a year ago we took proceedings—and we failed—to get a certain manufacturer to do this. We gave the six months notice and got the permission of the Local Government Board to proceed. When the six months were at an end, the case failed, because in the meantime the pollution had ceased; they had turned the pickle into a cinder heap, and at the time, or some little time before the hearing of the case, there was no pollution taking place at all.

14173. That was not legal failure to compel these people, because in fact they did stop the pollution in consequence of your action?—They stopped the pollution for the time being.

14174. If they began it again I suppose you could do that?—We could do that of course.

14175. That ought not to be a serious difficulty, and I am informed—of course I may be wrongly informed—that it is possible to evaporate the iron liquor so as to deposit the crystals of ferrous sulphate, and that these have a market value which probably will not give a profit, but will very largely repay the cost of putting down the necessary plant?—Well, that is the case in Glamorgan, in nearly all our works except those situated on the sea or on tidal rivers, copperas is made. There are only three where copperas is not made, and the whole of the pickle can be easily converted into copperas, and the cost some time ago for making a ton of copperas was about 10s. and then you would get for it is about 12s., so that can be done, it is easily done. But there is another effluent from our tinplate works. There are two, one is called the pickle, that is the spent acid, the other is called, the swilling fluid which is a very weak solution, in a large volume of water. It contains a little sulphuric acid. We have much more trouble with that, a great deal; we have one works on a particular river about seven miles from where the river enters the sea; at these works the whole of the pickle is converted into copperas in properly-constructed vats by evaporation and revaporating of the mother liquor, none goes into the river at all, but with regard to the swilling liquor we get trouble with that. That is to a certain extent acid, and although the water of this river is not used for drinking purposes by human beings, below this point it is used for drinking purposes by animals, and if they get other water they will not drink it, and we are continually getting complaints about this river.

14176. And is the amount of acidity very considerable?—Well, yes, especially near the works. As you go lower down the river it is not; it all disappears; it gets mixed with a large amount of water.

14177. (*Sir Michael Foster.*) What is the average amount of acid in the swill that leaves the works?—You have got two data on page 7 (168·5) and 41·1; swilling fluid is it?—That is swilling fluid, sir; the analysis of samples of the swilling fluid taken as it leaves the tanks is given below.

14178. (*Sir William Ramsay.*) Is that per 100,000?—Parts per 100,000, yes. We find a difficulty though in most instances to get this water as it leaves the works. They will not allow us as a rule. I tried to get a sample myself the other day from the works and I failed. It would not be much good if it was not as it was leaving, but these samples were taken as it was leaving the tanks.

14179. (*Sir Michael Foster.*) And the neutralization by lime is apparently unsatisfactory?—Unsatisfactory, sir, yes. The limestone gets encrusted in a very short time and becomes useless.

14180. There is a considerable quantity of iron?—Yes.

14181. And no attempt to recover it?—No; well, the iron will be deposited before it goes very far down the river in the form of oxide of iron, and that gives a yellow colour to the water. It is only in one instance in the county that any attempt has been made to purify the swilling fluid, but there are one or two other works that are preparing to put down the necessary plant to do so.

14182. (*Colonel Harding.*) What is just exactly the point you wish to bring before us; is it that you have not sufficient powers under the existing law to do these things?—The difficulty in Glamorgan is not with the sewage but with these two effluents.

14183. Is it that you have not the powers, or is it that having the powers you nevertheless cannot get the desired result?—Well, we have taken proceedings and we have failed.

14184. You have not shown us that you have failed, in the one case that you mentioned to us you do not appear to have failed?—Well, we did not succeed in getting them to put up the necessary plant.

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14185. But they have ceased polluting?—They have ceased polluting for the time being by putting it into the cinder heaps; it has not been going there very long and in my opinion it will ooze out from the cinder heaps into the stream again.

14186. You can take proceedings then?—We can take proceedings, but then we have to give six months notice.

14186*. Well. there were delays in the law, no doubt.

14187. (*Dr. Burn Russell.*) You say that your County Council have taken up the question of the purification of the rivers with great energy?—Especially with regard to sewage.

14188. You have appointed one County Sanitary Inspector to attend to these matters?—Yes.

14189. Do you find that sufficient?—Well, our rivers are all very short, and practically within the county. They have their origin just to the north of the county in the hills of Breconshire, but you may say they are practically all in the county. Our rivers are important, and there are many populous centres on them and very many works.

14190. Do you find that those installations for the purpose of purification require to be closely observed?—Yes, sir.

14191. Closely inspected?—And frequently inspected.

14192. I may say that in the County of Lanarkshire, where we have no special Act, but work under the Rivers Pollution Prevention Act, we have no difficulty at all in compelling the collieries to keep their dust out of the Clyde, but of course the decision of this Court will rule your proceedings?—That is so.

Mr. T. Whitaker.

MR. THORP WHITAKER, on behalf of the Bradford Dyers' Association, Ltd., called; and Examined.

14193. Are the positions and rights of the manufacturers and local authorities under the existing law clearly defined?

14194. Should the law be altered so as to give manufacturers greater rights than at present, to connect up with sewers?—We think the law has fulfilled its purpose.

14195. Are any further safeguards required to secure that the refuse shall be delivered in such a condition and in such regular quantities as not to interfere with the purification of the sewage?—The present safeguards are sufficient. The delivery of a dyer's effluent in regular quantities is not possible.

14196. Should further safeguards be required, what should they be, and how best could they be enforced?—Further safeguards are unnecessary.

14197. Are the manufacturers prepared to adopt means for the removal of suspended solids, grease, etc., from their trade refuse before being allowed to discharge into the sewer?—No, any such removal would be practically equivalent to a complete purification of the effluent, and such we contend should be done by the local authorities.

14198. Should there be some tribunal, such, *e.g.*, as a Central Government Rivers Board, to whom appeal could be made when a local authority refuse to allow trade refuse to go into the sewers?—A special tribunal is unnecessary, we think the present methods of procedure are sufficient.

14199. Should manufacturers be required to pay a special rate or charge in those cases where they are allowed to connect with the sewers. If so, how would you suggest that the amount should be determined?—No; the trade of a town is bound up with the town itself, and is rated accordingly, and the cost therefore should be borne by the authorities.

14200. What are the difficulties the manufacturer usually meets with in dealing with local authorities, and what are the reasons generally advanced by local authorities for refusing to allow trade refuse to go into the sewers?—Local authorities are difficult to please and are generally reluctant unless compelled to recognise their legal liability to take trade effluents into their sewers.

14201. What would be the effect upon the flow of water in the streams in those cases in which the manufacturer uses the water from the stream in his manufactory, if the trade refuse were delivered into the public sewers?—The proportion of water delivered to streams by us is often more than is taken from such source of supply, additional quantities being derived from deep wells and local authorities and a corresponding quantity might easily be delivered to the sewers without affecting the stream.

14202. In such cases is any alteration in the law desirable so as to get over the difficulty of riparian rights?—No alteration in the law seems necessary.

14202*. (*Colonel Harding.*) You appear on behalf of the Bradford Dyers' Association, Ltd.?—That is so.

14203. That is, I believe, a very important organization, including a large number of dye houses?—It s,

14204. Can you give us some general ideas; for instance, how many men are employed, or anything that would guide us in forming an estimate of the importance of the Association?—Well, I can not give you the number of men. I have not the figures with me.

14205. But speaking generally it is a very important organization and consists of how many distinct works?—Yes, there are 34 distinct works.

14206. And many of them turn out a very large volume of trade effluent?—Of trade effluent, yes.

14207. Can you give us any idea of what must be the total volume; perhaps you have not reckoned it up?—Well, roughly, I should say as far as water consumed—I will take it that way not the effluent—we shall use over 200,000,000 gallons a year.

14208. A year?—Yes.

14209. And that is simply the amount that you draw from wells or from various waters?—Yes.

14210. Does that take into account what you may draw from rivers?—Well, practically, I do not think we draw much from rivers.

14211. Then your works are all situated, are they not, on the water-shed of the River Aire?—Not all of them.

14212. Most of them?—Most of them, that is to say in Bradford or its neighbourhood.

14213. Well, they flow ultimately into the River Aire, at all events?—The bulk of them.

14214. You are personally acquainted with the condition of the streams that I am referring to the Aire and the tributaries of the Aire?—Oh, yes.

14215. You have not the good or evil fortune to reside on the banks of the River Aire between Apperley and Leeds?—No, I have not.

14216. But have you an intimate acquaintance with the condition of the river?—Oh, yes, I have.

14217. And you know the shocking condition of the river is largely due to trade effluents?—That is so.

14218. The advice that you give to the Commission in reply to the questions that have been asked you is that the condition of things as at present is all right, and that no alteration of any kind is required anywhere?—I take it you are not speaking now, of the river, you are speaking most with regard to local authorities——

14219. Well, you tell us that the condition of the law is, so far as the manufacturer, and so far as the local authority is concerned, all right as it is?—So far we have had no great difficulties with them.

14220. You have had no difficulty?—Not with the local authority.

14221. You say in one of your later answers to Question 8 "Local authorities are difficult to please and are generally reluctant unless compelled to recognise their legal liability to take trade effluents into their sewers"?—Yes.

14222. Then does not that suggest that there are difficulties with the local authorities?—I say no serious difficulties; no great difficulties with the local authorities; of course we have difficulties.

14223. Difficulties which are serious but not great?—No, certainly not.

14224. How do you draw the distinction?—As I say in my answers they are generally reluctant to accept trade effluent into the sewers, but I think, as a rule, sooner or later, we come to terms with regard to the matter; that is, they recognise their right so far as we are concerned to accept trade effluent.

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14225. I gather that you are under the impression that the trade has a perfect right to connect with the sewers?—We think so under the Public Health Act.

14226. But are you not aware that that has been frequently disputed?—Well, I suppose it has, but on the other hand I think it has been mostly given in favour of the manufacturer.

14227. Can you give me any case where a local authority has been compelled to receive trade effluent. You say "unless compelled." Can you give me any case in which a local authority has been compelled?—I say compelled to recognise their rights; I do not say actually compelled.

14228. Has there been any legal case bearing on that point, whether there actually is an obligation on the part of the local authority to receive trade effluent into its sewers. Do you know of any case?—Not in our immediate neighbourhood.

14229. You do not know of any case?—I do not know of any case in our immediate neighbourhood.

14230. But you say in this answer you find they are reluctant unless compelled. I thought you might know of a case where they had been compelled?—I qualify it there: "unless they are compelled to recognise that we have the right." I mean to say by being compelled, that they are reluctant at first, but on arrangement as to conditions they allow the trade effluents to go into the sewers.

14231. But surely there are a great many cases in which they say: "Our sewers are not large enough, and therefore we cannot take it at all on any conditions"?—That may be in outside districts; I do not think it is round Bradford.

14232. Then you think the condition of the law as it is, is amply sufficient?—So far as that goes, I think, as I say here, it has fulfilled its purpose.

14233. Well, let us say in the case of your variou works; you have 34 works?—Yes.

14234. How many of them are connected with sewers?-Well, I should say about half.

14235. Already connected with sewers?—Yes.

14236. And have you been called upon to carry out preliminary works of any kind before such connection? Yes, with regard to settling tanks, nothing else, no precipitation.

14237. Well, but on one of the questions you are asked, Are manufacturers prepared to adopt means for the removal of suspended solids; and your answer is, No?—Yes, heavy solids I am speaking of. I do not mean suspended solids. The tanks that we are obliged to put down by the local authority are not for suspended solids.

14238. What are they for?—They are for heavy solids.

14239. It is not for the lighter solids, it is for the heavy solids?—No, as a rule there is not the capacity in them, nor the room to put them.

14240. I notice another answer of yours in which you say in answer to Question 3: "The delivery of a dyer's effluent in regular quantities is not possible." Why not?—Well, by being not possible I mean we have no storage room to take the intermittent flow which must be in a dye-works so that we could deliver it regularly from such place into the sewers.

14241. But are not dye-houses in many cases, I know not in all, placed in situations where they have a fair amount of land round them?—No, they are not.

14242. Are none of your 34 works so placed?—Oh, certainly.

14243. Then in those cases it is possible to have a regular flow?—I should say if there is room sufficient. I mean to say if they have reservoir room sufficient to accept the 24 hours flow. I take it that is what you mean.

14244. Yes, because in many places, as for instance in Leeds, in some of the largest dye-works there, it has been found quite possible for them to do that, to empty their vats in such a way convenient to them, into a storage tank, whence it flows at a regular speed during the 24 hours?—Of course, a great deal depends upon the amount of effluent they may have.

14245. When you say it is not possible, surely that is too general a statement. There may be specific cases in which owing to the absence of land it may not be possible, but speaking generally of course it is perfectly possible?—I should say in the bulk of our works it is not possible to get a regular flow. By "regular" I mean to say there is not sufficient room to provide reservoirs of the capacity equal to a working day's supply. That is practically what it means, because if the reservoir was too small, it would simply flow in and out again.

14246. Evidently the reservoir must be of adequate size. Then what do you advise the Commission? You acknowledge, do you not, the shocking condition of the rivers, due largely to the presence of trade effluent?—Yes.

14247. You tell the Commission that your combined works turn out a vast volume of trade effluent?—Yes.

14248. Well then, what do you suggest may be done to improve the condition of the rivers. There are two things, are there not? The manufacturer may either treat his effluent himself, and purify it so as to satisfy the Rivers Board, or he may carry out preliminary conditions which may enable a local authority to receive it?—Quite so.

14249. Those are the only two courses open, are they not?—So far as I can see, the only two courses.

14250. Well, but you say that manufacturers are not prepared to do anything. In answer to Question 5 you say you are not prepared to do anything in preliminary works. Your answer is perfectly clear. You are asked "Are the manufacturers prepared to adopt means for the removal of suspended solids, grease, etc., from their trade refuse before being allowed to discharge into the sewer?" You answer plainly "No"?—As far as we are concerned, as dyers I mean, not as manufacturers.

14251. You are speaking of your particular business?—As far as dyers are concerned we contend that dyers' effluent is not to be classed in the same way as a comber's effluent, for instance that the amount of solids in suspension are infinitesimal compared with theirs.

14252. Then do you suggest to the Commission that it would be right and proper for a local authority to receive your dyers' effluents, large as their volume is, considerable as the quantity of suspended solids is, without asking a manufacturer to put down any preliminary works at all?—We contend that the suspended solids are not so great as to necessitate any works of ours, with the exception, as I said before, of the heavy solids, suspended solids apart.

14253. And you are sanguine that local authorities will ultimately receive all these effluents from your various dye works without preliminary treatment?—I think they will, and the Chairman of the Bradford Sewage Committee, in one of his speeches says:—"Some people thought that the municipality ought to insist on manufacturers' effluent being kept out of the drains. With regard to the dyers (this is the point I wish to make) the admission of their effluent was a distinct gain to the public health of Bradford. They discharged a large volume of antiseptic and highly disinfectant sewage. Its effect was to flush the drains, and to clear them of impurities that came from domestic and private establishments. If there was not that quantity of water turned down in a dry season these impurities would decompose, and perhaps cause a serious epidemic."

14254. Your effluent no doubt is of a different character altogether to many of these effluents?—Quite so.

14255. But the main point which we are speaking of here at this moment is as to the previous settlement of the suspended solids before the liquid portion of your refuse is turned into the sewer. What is the difficulty in the way of your companies carrying out the preliminary works which any local authority may require them to carry out?—I contend we are doing that to-day for the local authorities; any effluent of ours is being treated to take out the heavy solids. Solids in suspension have never yet been asked for, at any rate under the Public Health Act, or in any Bill relating to public authority in Bradford have we ever been asked for suspended solids to be taken out. Heavy solids, yes, but not suspended solids.

14256. Are there not large quantities of indigo and the dye stuff go into the effluent which must properly be kept out of it?—They are very foolish if it does go in, in our case I should certainly say not.

14257. Well, I have noticed in some cases where the whole volume of the sewage, which considerably dilutes the dyers' effluent, is deeply tinged with colour?—Do you mean indigo?

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14258. Well, I do not know that it was indigo, but it was a deep indigo colour?—Because, of course that could not be in the Bradford district; it would be in the heavy woollens.

14259. It was in the neighbourhood of Rodley?—Where cloths are dyed, not such stuffs as are dyed in Bradford.

14260. (*Sir Michael Foster.*) What dyes do you chiefly use?—Chiefly the artificial colouring dyes.

14261. (*Sir William Ramsay.*) Do you soap your goods before they leave your works?—In many cases soaping is not altogether necessary, that is to say, they are not so heavily filled and so dirty as heavier goods such as gentlemen wear; they are usually thin fabrics such as ladies' dress goods.

14262. But the effluent must contain, I suppose, a certain amount of spent soap?—Our effluent does not contain as much as a domestic sewage from the same district would contain.

14263. Of soap?—There again I can quote from the Chairman of the Bradford Sewage Committee. He says:—"In certain districts where no manufacturing effluent gets into the sewers, there is 1¼ tons of grease per 1,000,000 gallons." Well, in our case we contend there is not anything like that quantity in our effluent chiefly owing to the dilution by the immense volume of water we use.

14264. Is the effluent coloured?—Certainly.

14265. A mixture of darkish colours. You do not recover the unused colours?—Oh no, it is impossible.

14266. You take no steps to remove the colour?—We cannot.

14267. (*Col. Harding.*) Then manufacturers are unwilling to put down settling tanks to satisfy the local authorities. We may take it that they are still more unwilling to put down the necessary works to satisfy Rivers Boards where the effluent goes into the rivers?—Well, of course, as far as local authorities are concerned, we have had no complaint from them as to what we are doing.

14268. (*Chairman.*) May I just ask you what I do not quite understand. Your answer to one question would seem to show that manufacturers are not prepared to adopt means for the removal of suspended solids, grease, etc., from their trade refuse, but now in your further examination you seem to me to limit that answer to the extent of suspended solids in your own trade refuse?—Quite so.

14269. And your argument is that you do not remove them because there are so few of them?—That is so.

14270. Supposing the amount of them was large, would you think it fair that you should remove them then?—Suspended solids?

14271. Yes?—Well, you would have to qualify the word "suspension" there. We may have an effluent which is not colourless, but clear from suspended solids, but after, say, a few hundred yards running in the stream it begins to oxidise and deposit colouring matter. In the one case it leaves our works perfectly clear if you like to term it so, not colourless, but without matters in suspension.

14272. If there was a large amount of solids in trade refuse, would you consider it fair generally speaking that the manufacturer should remove them?—I should qualify the term "solids." You mean heavy solids in that case.

14273. (*Sir Michael Foster.*) You would think it fair that he should remove heavy solids?—Heavy solids certainly.

14274. You have no heavy solids in your effluent?—We have no heavy solids.

14275. Your contention is: you mean that your effluent is one which does not interfere with the ordinary treatment of the sewage?—It is.

14276. And that its addition to the sewage is rather a benefit to the sewage than otherwise?—Quite so.

14277. (*Sir William Ramsay.*) You are not speaking generally. You are merely answering on behalf of the Bradford Dyers' Association?—That is so.

14278. (*Colonel Harding.*) Have you ever inquired whether it interferes with the treatment of sewage? Have I ever inquired?

14279. Yes?—Well, I give you the word of the chairman of the Sewage Committee, who says that it does not.

14280. It does not in your case?—Quite so.

14281. (*Sir Michael Foster.*) Does not your intermittent flow interfere with the treatment of the sewage? Well, I could not answer that question; we have not been complained of with regard to the matter.

14282. (*Colonel Harding.*) I suppose in such cases the effluent even from efficient sewage works would be deeply tinged with dye?—Well, I should say it would certainly be modified in that case, because the mere fact of coming into contact with other bodies in the sewage may tend to decolourise it to a great extent.

14283. You have never had an opportunity of seeing the sewage of a large city deeply coloured with dye even after it has passed through various processes of sewage treatment?—I have not; I have seen it certainly coloured after it has passed through the sewage processes.

14284. You have not been able to realise the improvement which takes place if the dye you allude to flows through at a regular speed in the 24 hours?—No, I have not been able to do that.

14285. (*Sir William Ramsay.*) Is it possible that the various works belonging to the Association discharge at different times, so that the flow is made uniform where a great number of works are connected with different sewers?—Well, of course the works as a rule begin at one stated time and finish at one stated time, and their effluent goes through the ordinary cycle of a day's work.

14286. The discharge would probably take place about the same hour at each works?—About the same hour in many cases. It is difficult altogether to say exactly whether it is so or not.

14287. (*Sir Michael Foster.*) You do not know the total volume of the sewage into which you are discharging?—Our total volume of the sewage?

14288. Yes. You discharge about two-thirds of a million per day apparently?—Two-thirds of a million at all our works.

14289. Rather more than two-thirds of a million gallons a day, you say 200,000,000 gallons in the year?—Yes, that is so, of water consumed.

14290. Well, what proportion is that of the total of the sewage?—Bradford use 12,000,000 gallons a day, I believe that is their supply daily of water.

14291. (*Colonel Harding.*) Their dry weather flow is about 12,000,000 gallons a day?—Yes, I think so.

14292. (*Sir Michael Foster.*) So that you are a very considerable fraction of the total sewage?—Quite so.

14293. And it makes no difference to the treatment of sewage whether that is discharged nearly all at once or regularly distributed during the 24 hours?—So far I say we have had no complaint whatever in regard to it.

14294. (*Sir William Ramsay.*) Do you take your water from the stream or from wells or the town supply?—Deep wells and from the town supply; also from streams, but not from any rivers specially.

14295. And is the stream discoloured before it reaches you?—Not in many cases.

14296. It is?—No; in some cases it is, especially on one stream in Bradford it is discoloured.

14297. But the water is frequently clear before it reaches you?—Well, I do not say it is practically clear, I think there is a little matter in suspension, but not a great deal.

14298. Would it be possible for you to use water for scouring already polluted by dyestuffs and which was already highly discoloured?—Not easily in that case, it would mean separation of the effluent.

14299. (*Colonel Harding.*) Then the purity of streams is evidently of value to the manufacturer?—Certainly, by all means, if the stream is to be drawn from it is of importance to the dyer.

14300. Then you agree that it is necessary that something should be done to attempt to purify the streams?—We are quite willing to do anything in reason.

14301. And you think that other manufacturers in other trades may properly be called upon to settle solids, remove grease, and do a good many things?—As far as that goes I take it that the conditions vary to each manufacturer; I take it that in each case reasonable means should be used.

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14302. (*Sir Michael Foster.*) By the manufacturer?—By the manufacturer, yes. I am speaking of course, now generally. So far as we are concerned we contend that we have no difficulty with the authorities as yet, excepting in the case of the Rivers Board, and that our effluent is comparatively a good one as compared with others in the district.

14303. (*Colonel Harding.*) You think it is quite right that these other persons should be called upon to do something for the purification of their effluents?—I say reasonable means should be taken, I quite agree with that: the question is what means are reasonable.

14304. Quite so. But in regard to the dyers, you do not think it is reasonable to ask them to do anything?—Certainly I do not say so.

14305. Except as you said the settlement of heavy solids?—Exactly.

14306. (*Sir Michael Foster.*) But you are not asked to do anything, I understand?—By the——?

14307. By the local authority?—Heavy solids, yes.

14308. But you have no heavy solids you say?—Well, whatever heavy solids we have, we have to take out.

14309. You may have from time to time heavy solids?—The only thing that we may have in the way of heavy solids, as we term it, is spent dye wood.

14310. Those you take out?—Those we do take out.

14311. In all cases?—In all cases.

14312. (*Colonel Harding.*) You have no trouble with the local authority, nor with the Rivers Board?—With regard to——?

14313. With regard to your various effluents?—Oh, yes, I believe we have with the Rivers Board.

14314. They do not agree with you that they are so innocuous?—That is quite so, I believe.

14315. And they are in fact doing all they can to compel you to purify them?—I daresay.

14316. And we gather from your answers that you do not see any necessity for doing anything?—You are speaking now from another point of view. I understood this was from a local authority point of view, rather than a Rivers Board question.

14317. Well, what we are trying to do is to get information in regard to the treatment of trade effluents, and we see there are two courses open. One is for manufacturers to purify it themselves, the other is to get the local authority to receive it into their sewers subject to conditions to be agreed. We see that there are those two courses. We are asking for information, and you tell us there is no difficulty with the local authority at all?—That is so.

14318. Still there are cases surely where your effluents cannot go into the sewers?—Yes.

14319. In these cases are the manufacturers prepared to do what is necessary to satisfy the Rivers Board?—As I said before, to do what is reasonable.

14320. They are prepared to do something, and their limitation is the reasonableness?—I think the limitation is as given in the Act—the West Riding Rivers Act.

14321. (*Sir Michael Foster.*) Who is to determine the reasonableness?—Well, I do not know whether the Act states that or not.

14322. (*Colonel Harding.*) In the event of disagreement between the manufacturer and the local authorities as to what should or should not be done, do you think it would be desirable to have some other body to appeal to, than the ordinary magistrates or other legal courts?—No, I do not; so far as we have gone I do not see the necessity of anything in that case.

14323. You do not think a central body having the special matter in hand would be useful?—No, I do not think so.

14324. (*Sir Michael Foster.*) Would you leave it with the Rivers Board to say what was reasonable?—With regard to——?

14325. With regard to the treatment of your effluent?—No, I am speaking now with regard to local authorities; that is the difference.

14326. (*Colonel Harding.*) You would not appeal to the Rivers Board to settle the matter between you?—Well, no, I should say that would hardly be to our——

14327. It would not have your confidence?—No, I should think not.

14328. The Rivers Board are in fact pressing you in certain cases?—Quite so.

14329. (*Chairman.*) Well, but now in the event of a dispute between a manufacturer and the Rivers Board, or a manufacturer and a local authority, the only appeal is to the regular law Courts?—I believe so, yes.

14330. Do you not think that a special body of experts would be able to decide in a much more rapid and less costly manner than an ordinary Court of Law, where lawyers have to be employed on both sides?—Well, it is a matter on which I think from our point of view, as dyers, a special tribunal is not necessary. We hold that our effluent, though coloured, is innocuous, and as such can be admitted to sewers without detriment to either sewers or sewage.

(*Sir Michael Foster.*) But if the local authority will not admit that?

14331. (*Chairman.*) You cannot expect to be sole judges in your own case?—Well, that is true, but I really could not give any case where this thing has not been amicably arranged, in our immediate neighbourhood at any rate.

14332. (*Colonel Harding.*) What about the half cases where you are not connected with the sewers? You say, out of 34, about half are connected with the sewers?—Yes.

14333. Well, is there no dispute in the other half, in trying to get connected with the sewers, or what is being done?—I think in one or two cases they are trying to get connected with the sewers.

14334. What is the difficulty in the way?—The difficulty in the way is, first of all, the Corporation, I think, say the sewers are not large enough. I think, this is the chief reason.

14335. The sewers are not large enough?—I think so, yes.

14336. You think in that case it is quite right that they should refuse to take it?—I think that the local authority certainly ought to provide sewers in connection with its own district sufficiently large to take cases of this kind.

14337. And you think if sewers are not large enough they could make them so?—I certainly think so. The town is bound up with the trade of the town, and as such ought to be made in the manner I have stated.

14338. (*Sir William Ramsay.*) Are the manufacturers very largely represented on the Corporation in Bradford?—Speaking from our own point of view, no.

14339. (*Major-General Carey.*) Do you abstract part of the water for your works from a stream?—Yes, or deep wells.

14340. And is that water sent into the sewers, or is it returned to the stream?—In many cases it is returned to the stream.

14341. In some of the works in which you draw water partially from the stream, how do you know what proportion you take from the stream, and what from the town mains?—I do not quite understand you.

14342. You draw part of the water for the works from the stream?—Yes.

14343. You return part of the water to the stream?—Yes.

14344. Do you return the whole of the water that you have taken to the stream?—Not in all cases. In certain cases we are compelled to return it to the stream on account of the rights of other manufacturers or dyers.

14345. In no case are the particular works supplied partly from the stream, and partly from the town mains?—Oh, yes.

14346. How do know what proportion to return to the stream?—Probably more in that case would be returned to the stream. It entirely depends as to the position of the works. In some cases, of course, owing to the configuration of the ground, they are unable to return it to the sewers, in that case of course it goes into the stream.

14347. Has any complaint ever been made by riparian owners about the extraction of the water from the stream not being returned?—I think usually the case is met amongst the people themselves on the stream, they look after their own rights, and I think as a rule they are reasonable with each other and accommodate themselves to the individual wants.

Alderman Sir B. T. Leech.

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Alderman Sir BOSDIN T. LEECH (Chairman of the Manchester Rivers Committee), called; and Examined.

14348. (*Chairman.*) Do you admit manufacturing refuse into your sewers?—Yes. When the new Manchester sewage scheme was undertaken the old sewers (into which trade refuse was sent) were, under legal advice, coupled up. Other concerns drained into the rivers, and were under the jurisdiction of the joint Rivers Board. These and also new works when they apply, are now obliged to subscribe to our conditions before being allowed to enter the city sewers.

14349. What are the kinds of refuse and what is the volume as compared with the volume of ordinary sewage?—Manufacturers' and chemical refuse; also from breweries, tanneries, dye works, galvanizing works, indiarubber works, and the numerous other works carried on in a large town. The volume is very variable. Possibly it may average 5 to 15 per cent. of the total quantity.

14350. Do you find that the admixture of trade refuse materially increases the difficulty of treating the sewage, apart that is, from necessitating an increase in the size of the works and, if so, from what does this difficulty arise, *e.g.*, from the condition or kind of the refuse, or from its volume as compared with the volume of sewage proper?—The admixture of trade refuse vastly increases the difficulty of treatment. The character of the sewage is constantly varying, and as the chemical and trade refuse is often discharged in bulk it needs constant and narrow supervision and treatment in order to counteract the acids and alkalis therein contained. The condition and kind of refuse is of greater difficulty than its volume.

14351. Do you think a local authority should be empowered to construct sewers for trade refuse alone?—If a model town were to be built I should advise constructing a dual system of drainage. The surface rain and unpolluted water to flow into the watershed, and a deeper system of drainage to take sewage and trade refuse, there being provision for flushing the latter by the former when necessary. I am not prepared to recommend trade refuse drainage *per se.*

14352. Are the positions and rights of the manufacturers and local authorities under the existing law clearly defined?—I should say no, though we have done much in Manchester to get a clear definition. Where no sufficient sewers exist there is great doubt about the liability for provision in order to take away and deal with trade refuse. The question is:—Are local authorities bound to supply adequate sewers for the purpose?

14353. Should the law be altered so as to give manufacturers greater rights than at present to connect up with the sewers?—No; inasmuch as manufacturers greatly benefit in convenience and cost by being able to turn their effluent into the sewer, it would appear they have no claim to an increase of existing rights.

14354. Are any further safeguards required to secure that the refuse shall be delivered in such a condition and in such regular quantities as not to interfere with the purification of the sewage?—The interests of the public ought to be safeguarded to the fullest possible extent. Manufacturers' refuse ought to be delivered in such a state that it will not create a nuisance or be detrimental to the structure of or free passage in the sewers. It should be introduced in regular quantities and not in bulk. Manchester has been successful in getting exceptional clauses in Session 1902.

14355. Should further safeguards be required, what should they be, and how best could they be enforced?—Producers of manufacturers' refuse ought not to be called upon to purify river water before using it. On the other hand, they ought to purify after using; and to this end they ought to have sufficient tank space to allow of settlement, and, if necessary, they ought to be obliged by the Legislature to use precipitants or antidotes and to turn their effluent either into sewers or streams in a fairly pure condition.

14356. Do you find that the manufacturers are willing to adopt means for the removal of suspended solids, grease, &c., from their trade refuse before discharging it into the sewer?—Manufacturers must see that all waste is extravagance, and the sensible ones, are, as a rule, anxious to prevent matter going into sewers that could be profitably made use of otherwise, but there are many who have not space to deal with the refuse, and herein lies a great difficulty. A few cannot afford to put down the necessary plant or erect apparatus for pumping into tanks at a higher level.

14357. Should there be some tribunal other than the ordinary Court of Law such, *e.g.*, as a Central Government Rivers Board, to whom appeal could be made when a local authority refuse to allow trade refuse to go into the sewers?—An arbitrating central power would be of great service to push forward the dilatory and relieve the willing horse, but it seems to me the law should more clearly define the rights and positions of authorities and manufacturers in regard to the dealing with trade refuse.

14358. Should the manufacturers be required to pay a special rate or charge in those cases where they are allowed to connect with the sewers. If so, how would you suggest that the amount should be determined?—No, unless under special circumstances. If cost is incurred in taking manufacturing refuse to a main sewer, or if it can be ascertained that additional cost will be incurred in dealing with it, a special rate ought to be charged. In the former case, I would deal with it as in the case of water supply. If a manufacturer, to get cheap land, builds in an out-of-the way place and wants water, he has to pay the extra cost of bringing it. So in the case of the removal of house garbage a distinction is made, some is free, and some has to paid for. The amount of special rate would be a matter of consideration.

14359. What are the reasons generally advanced by local authorities for refusing to allow trade refuse to go into the sewers?—Insufficiency of the sewers in size. That there is no provision for dealing with the effluent at the outlet, when it is abnormally acid or gives off poisonous gases. That it is not equitable to tax a district to purify the foul matter created say by one manufacturer in the course of carrying on a profitable business. Fear of coming within the clutches of a Joint Rivers Board.

14360. What would be the effect upon the flow of the water in the streams in those cases in which the manufacturer uses the water from the stream in his manufactory, if the trade refuse were delivered into the public sewers?—In many cases in country districts the results would be disastrous. A stream will have a dozen or more mills or manufactories, each in turn using the water, and in many cases, having first to purify the water before using. If the first user were to turn his effluent in the sewer instead of back again he would starve all the rest.

14361. In such cases is any alteration in the law desirable so as to get over the difficulty of riparian rights?—Yes. A riparian owner gets his water free of cost. Others have to pay for town's water. The former ought to be obliged to have sufficient space to put down tanks and other means of purification so as simply to borrow the water for a time and return it to the stream or river in the same state he took it. It is manifestly unfair to allow him to take water that costs him nothing rob his neighbours down the stream of it by putting into the sewers, and then expect the whole district to pay the cost of erecting works to purify refuse which they have had no hand in creating.

Councillor C. Dreyfus.

Councillor CHARLES DREYFUS (Deputy Chairman of the Manchester Rivers Committee), called; and Examined.

14362. (*Chairman.*) Do you admit manufacturing refuse into your sewers?—Yes, under special regulations, of which I submit a copy marked "A", which are based on the Public Health Act, 1875, the Rivers Pollution Prevention Act, 1876, the Public Health Acts Amendment Act, 1890, and the Manchester Corporation (General Powers) Act, 1902.

14363. What are the kinds of refuse, and what is the volume as compared with the volume of ordinary sewage?—The manufacturing refuse of Manchester consists of the effluents of a variety of trades, the principal ones being breweries, mineral water and chemical works, such as sulphuric acid, nitric acid, hydrochloric acid works, alkali works, tar distilleries, sulphate of

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ammonia works, gas works, aniline and aniline dye works, bone works, acetic acid works, chloride of sulphur and bi-sulphide of carbon works, oil refineries, tallow melting, soap and candle works, indiarubber manufactories, dye, bleach, and print works, galvanising works, tanneries, slaughter houses, and all sundry industries carried on in a large city like Manchester. Personally, I am not in a position to give even an estimate of the volume of such trade effluent. I have seen the figures given by Mr. Fowler, and I think they are not far wrong. This volume is made up largely by condensing water from stills, which is taken from canals, wells, or even town's water, and the smallest volume of it is actually trade refuse.

14364. Do you find that the admixture of trade refuse materially increases the difficulty of treating the sewage, apart that is, from necessitating an increase in the size of the works; and, if so, from what does this difficulty arise, *e.g.*, from the condition or kind of the refuse, or from its volume as compared with the volume of sewage proper?—The admixture of trade refuse does certainly increase the difficulty of treating the sewage, at present, when our new powers are not yet in force. For example, galvanising works in our city have been in the habit of sending large quantities of free acids into the sewers, which we have to neutralise with lime before we can allow them to undergo the chemical treatment. Perhaps they may not be so injurious to the open septic treatment, but our new powers are a sufficient protection, in my opinion, against this cause of mischief. From sulphate of ammonia works we often get quantities of sulpho-cyanates, which are objectionable, but I do not see how we can prevent their admission. What we propose to do in reference to this and similar injurious matters is to see that their admission takes place only in a slow flow, which will have the tendency to dilute them considerably, and thus render them easier of treatment.

14365. Do you think a local authority should be empowered to construct sewers for trade refuse alone?—I do not think that under existing circumstances any local authority of any magnitude would ask for powers to construct sewers for trade refuse alone, the cost would be so very heavy: but where new districts are being created such a thing as having two systems of sewers, one for trade refuse and storm water, and the other for domestic sewage only, might be useful.

14366. Are the positions and rights of the manufacturers and local authorities under the existing law clearly defined?—There is much ambiguity in the existing law, see Guthrie and others *v.* Magistrates of Brechin, and Peebles *v.* Oswaldtwistle District Council, and I only hope that the additional Act of Manchester of 1902 will make our position clearer.

14367. Should the law be altered so as to give manufacturers greater rights than at present to connect up with sewers?—Manufacturers, as ratepayers, and so long as they comply with the regulations based on Acts of Parliament, should have full rights to connect up with sewers. The contrary would be a great hardship, and would in many cases prevent the spread and extension of our industries on which we live.

14368. Then, are any further safeguards required to secure that the refuse shall be delivered in such a condition and in such regular quantities as not to interfere with the purification of the sewage, and, if so, what should they be, and how best could they be enforced?—Reasonable safeguards are of course necessary, and these are already mentioned in the various Acts of Parliament dealing with the question.

14369. Do you find that the manufacturers are willing to adopt means for the removal of suspended solids, grease, &c., from their trade refuse before discharging it into the sewer?—Yes. They are prepared to construct catch pits and settling tanks when called upon to do so, and this may be made in every case a condition before admission of their effluents is allowed into the sewers.

14370. Should there be some tribunal other than the ordinary Court of Law such, *e.g.*, as a central Government Rivers Board, to whom appeal could be made when a local authority refuse to allow trade refuse to go into the sewers?—A central Government Rivers Board, composed of experts in this very difficult matter, would be preferable to any existing jurisdiction, provided, however, that it acts promptly and without heavy costs to the parties.

14371. Should the manufacturers be required to pay a special rate or charge in those cases where they are allowed to connect with the sewers. If so, how would you suggest that the amount should be determined?—Manufacturers, being ratepayers, should not be asked to pay a special rate. Such a thing would be very injurious to the trade of the country. By having to construct catch pits, settling tanks, and using in some cases neutralising materials, they are already put to some considerable expense.

14372. What are the reasons generally advanced by local authorities refusing to allow trade refuse to go into the sewers?—Manchester has not to my knowledge refused trade refuse to go into the sewers, if manufacturers have signed our regulations and comply with them. I am not able to say what other authorities object to in the admission of trade refuse.

14373. What would be the effect upon the flow of the water in the streams in those cases in which the manufacturer uses the water from the stream in his manufactory if the trade refuse were delivered into the public sewers?—The flow of the water in the stream in cases in which the manufacturer uses such water and does not return it to the stream would be less, and in case of a stream with small flow, or during dry weather, it might have a serious effect on the state of such stream, and in the conduct of the business of the works of the riparians.

14374. In such cases is any alteration in the law desirable so as to get over the difficulty of riparian rights?—There seems to be a great difficulty in legislating for such a case.

MR. GILBERT JOHN FOWLER (Superintendent and Chemist of the Manchester Sewage Works), re-called; and further Examined.

Mr. G. J. Fowler.

14375. You admit manufacturing refuse into your sewers?—Yes.

14376. What are the kinds of refuse and what is the volume as compared with the volume of ordinary sewage?—The following is a careful estimate of the character and quantity of the chief trade effluents in Manchester:—

	Gallons per day.
Brewers, bottlers, mineral water makers, &c.	700,000
Dyers, bleachers, &c. - - - - - -	600,000
Tanners, leather-dressers, &c. - - - -	20,000
Oil and grease refiners, candle makers, &c. -	50,000
Indiarubber works - - - - - -	40,000
Soap, size, &c., works - - - - -	35,000
Galvanizers and brass finishers - - - -	550,000
Chemical manufacturers, including sulphate of ammonia works, tar distillers, aniline works, alkali, &c. - - - - - -	650,000
Slaughter-houses (including public abattoirs), tripe dressers - - - - - - -	10,000
	2,655,000

This may be taken at 10 per cent. of the daily dry weather flow.

A large proportion of this volume is made up of comparatively uncontaminated liquids, such as cooling water and washing-off water.

In our sewers, and not included in the above list, are large volumes of hydraulic engine water, water run off from the public swimming baths, condensor water, &c.

14377. Do you find that the admixture of trade refuse materially increases the difficulty of treating the sewage, apart that is, from necessitating an increase in the size of the works, and, if so, from what does this difficulty arise, *e.g.*, from the condition or kind of the refuse or from its volume as compared with the volume of sewage proper?—Yes, for the following reason:—

(*a*) The large quantity of iron pickling refuse greatly increases the volume of the deposit in the septic tank, and also the amount of insoluble matter going on to the beds. This is, however, rather a matter affecting the cost of purification than the actual chemical changes involved. It should however be mentioned that the chemical treatment to which the bulk of the sewage is at present subjected, pending the complete adoption

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of the bacterial system, is rendered more difficult owing to sudden flushes of acid refuse. Constant vigilance is necessary on the part of the workmen in order to adjust the addition of the lime and copperas to the varying character of the sewage. In the presence of iron pickle the addition of copperas is of course discontinued, and the amount of lime added in some cases greatly increased.

(*b*) Certain effluents, *e.g.*, naphtha-washings and carbolic acid, ammonia recovery liquor (containing sulpho-cyanates) and some dye-waste greatly increase the oxygen-absorbing power of the sewage, and so increase the difficulty of bringing the effluent within the limits fixed by the Mersey and Irwell Joint Committee. It is probable that much of the nitrate which would otherwise appear in the effluent is used up in oxidising these various dissolved impurities.

(*c*) Although the amount and character of the trade refuse has never been such as to effect complete sterilisation of the sewage, experience would show that the period of ripening of both septic tanks and bacteria beds is prolonged by the presence of trade waste. When the tanks and beds are fully ripe the purification is only affected under very exceptional circumstances. The following observations may be of interest. On December 2nd, 1899, an accidental discharge of ammonia recovery liquor into the sewer raised the oxygen absorption figure of the closed septic tank effluent to upwards of 24 grains per gallon; this was reduced by the filters dealing with this tank effluent to 2·56, and no subsequent ill effects were noted. Half acre beds, which after several weeks' working failed to give a non-putrefactive effluent when only filled six times a week, two hours' contact being allowed, immediately gave non-putrefactive effluent when the period of contact was increased to 12 hours. With Manchester sewage therefore the best method of starting new beds appears to be to fill not more than once a day, giving at least 12 hours' contact, this period of contact being gradually reduced as the beds become more mature. With beds which have been in use for several years, the total period of filling, standing full, and emptying need not exceed two hours.

(*d*) An experiment has been recently made as follows:— A sample of sewage was inoculated with septic sludge, and a series of bottles filled with the mixture. Into each bottle was placed a small portion of a particular trade effluent, and an arrangement was made for estimating the gas evolved in each case, one bottle of the series being left in its original state. In no case was the septic action actually stopped, but considerable variation was shown in the amounts evolved in each case. A similar result was obtained in a series of observations made where varying amounts of salt was added to the mixture. The rate of evolution of gas, however, tended to become more equal, in all cases, after the lapse of some days. These experiments confirm therefore the conclusion of general experience, that the effect of trade refuse is to increase the period required for the bacterial activity to attain its maximum, but is not sufficient, as a rule, to permanently affect the working of the various bacterial processes.

14378. You appear to be rather in favour of a special central body, before whom disputes between manufacturers and the local authorities should come?—(*Sir Bosdin Leech.*) That is my view, because I think a central body would view local questions more dispassionately. I think they perhaps would not be so very hard upon bodies who were doing their very best, and there would be no local feeling at all to prevent them taking steps against individuals or authorities who are not proceeding with their work as they ought to do.

14379. And you would think or at any rate hope that such a body would be able to come to its decisions at less cost of time and money than the ordinary Law Courts?—I certainly think so.

14380. (*Colonel Harding.*) Mr. Fowler the effect of the interesting evidence you bring before the Commission is that the presence of a considerable volume and variety of trade effluents in admixture with domestic sewage does not prevent the successful treatment of the sewage, although it adds greatly to its difficulties?—(*Mr. Fowler.*) That is my conclusion.

14381. And where bacterial processes are being used you find that it delays bacterial action, but does not absolutely check it?—Yes.

14382. And that it takes up oxygen which otherwise would be available for oxidising organic matter?—Unquestionably.

14383. But on the general question I suppose you would agree that in a place like Manchester, where you have a large variety of trades, it is for the general convenience that they should be received into the sewers and dealt with wholesale at the sewage disposal works, rather than that the manufacturer, with all the difficulties that would attend his dealing with it in a town, should be called upon to treat his effluent himself?—Speaking generally, yes.

14384. Of course there are specific cases where probably you might be disposed to make exceptions?—Yes.

14385. What has been the effect of the pickle in your sewage: has it added much to your difficulty, or has it been on the whole useful?—It has been to some extent useful in regard to our chemical treatment, inasmuch as of course it acts as a precipitant; speaking now simply from the point of view of chemical precipitation, if we could induce the manufacturers to send it down in a regular stream, as I know one of the chief firms in Manchester is now endeavouring to do, from the point of view of chemical treatment it would not greatly harm us, in fact might even be helpful, but there is no question from the point of view of the septic tank, it does interfere with us, inasmuch as the sulphide of iron adds to the bulk of indestructible sludge, and also passes away on to the filter beds, and has to be removed from them from time to time. It oxidises eventually to oxide of iron. Some of that will find its way into the pores of the bed and some of it get removed from the surface from time to time, but I certainly should be glad if it were possible to keep the iron out altogether. I fear it is not possible, and of course it does not actually interfere with the processes, but it does add to the cost and difficulty of treatment.

14386. (*Sir Michael Foster.*) It is quite serious, you think then it makes a serious difficulty?—Well, I do not know that; I would say it is simply serious as regards cost; as regards the actual purification I do not think that it matters very much, in fact, an observation occurs to my mind where the sewage was full of iron pickle, and a sample was taken for bacteriological examination, and there were crowds of bacteria present in the sewage in spite of the presence of acid liquor. It is a question, of course of more or less, I should imagine. In Manchester we are not so badly off as in Wolverhampton, certainly, and possibly not so badly off as in Leeds. If the iron pickle was more in volume than sewage, then it would be a very serious question to deal with.

14387. (*Colonel Harding.*) In your case it has not been serious?—No.

14388. It has simply added to the solids which you have had to remove from your septic tanks and filters?—That is really the point.

14389. Then trade refuse, which may be a serious difficulty when it comes in rushes during short periods of the day, ceases to be a serious difficulty if it is sent down spread over the 24 hours pretty equally?—That is so.

14390. (*Major-General Carey*). Does that apply to all descriptions of trade refuse?—There are certain possible exceptions. I mean to say, if large quantities of benzole washings of a very strong description were constantly sent down, then it does increase the difficulty. The beds do not seem to do their work as well. We have had periods when we have had a great quantity of this kind of stuff which certainly to some extent inhibited the action, even with old beds that were thoroughly matured. It has not stopped it, you understand, but simply as it were inhibited the activity to that extent; but it seems to me that it should be possible to treat such an effluent at the works in a way to minimise the danger. I cannot conceive but what there must be waste going on when you have such vast quantities as that.

14391. (*Sir Michael Foster.*) But with a certain number of and probably few exceptions, you are prepared to take the trade refuse untreated into your works?—I would not say untreated. I should ask the manufacturer to keep out as much of their solids as possible because, of course, it is all added cost to us at the works to take out the solids, which they could easily do themselves. Of course this is altogether apart from any question of nuisance and danger to health. I am speaking now

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simply as regards the treatment. The matter of course can be looked at from another point of view, which possibly the Commission will be coming to presently, but in my remarks so far I have simply considered the treatment of many effluents which would not interfere with the treatment because their volume is comparatively small, but which have to be kept out of the sewers for other reasons.

14392. (*Colonel Harding.*) Just one question, Mr. Fowler. You said just now, that the manufacturer would quite readily settle these solids himself. There are of course exceptional cases where, owing to the complete absence of spare land, he cannot, it is physically impossible for him to put down settling tanks. In those cases it has been suggested to us—I would rather like your opinion upon it—that a Corporation might receive the effluent nevertheless, and if put to additional expense, owing to the additional quantity of suspended solids that they would have to deal with at their works, they might lay a special rate or lay a special charge on that manufacturer. That is a suggestion that has been made to us. Do you think it would be possible to estimate the additional cost in such a case at the works: would it be possible in any way to form an opinion, judging from the average suspended solids in the effluent from a particular works, would it be possible to estimate the additional cost to the Corporation and so charge it to the manufacturer?—Oh, I think it would be quite possible to make a fairly close estimate. I should be sorry for the contingency to arise. I think it is very much better if possible for the stuff to be treated at the works, and as regards Manchester I know of very very few exceptions where it is not possible; of course it is a question of cost at the end whether special arrangements of depositing towers and so on might be used where there is very little space for large settling tanks. There it becomes a question of cost, and possibly the manufacturer in such a case might be inclined to pay the cost rather than pay a rate to the Corporation, but if it should come to the question of assessing the cost of an effluent I think it could be done. We know how much sludge costs per ton to get rid of and so forth, and we could estimate the quantities of tons of liquid sludge that these suspended solids would produce, and so on.

14393. I should like to ask Sir Bosdin Leech one or two questions. Sir Bosdin, I see that in Manchester your Corporation realise that it is to the advantage of the City as a whole that you should give facilities to manufacturers by taking their effluent into your sewers where it is possible to do so?—(*Sir Bosdin Leech.*) That is so; we have however regulations and conditions.

14394. Yes, you make conditions, but speaking generally?—As to the amount of matter in suspension and as to the rateable flow. If the conditions are complied with we see no objection at all to taking manufacturers' refuse.

14395. Under the fulfilment of proper conditions you receive trade effluent into your sewers?—Yes. I have here a copy of our conditions at the present time. We find that the manufacturers and general business firms comply with them.

CITY OF MANCHESTER TRADE REFUSE.

Regulations for Admission of Trade Refuse into Sewers.

1.—All liquid trade refuse from the manufactory shall be passed into and through suitable settling tanks to be approved by the Corporation the same to be constructed and at all times maintained by and at the cost of the Owner to the satisfaction of the Corporation.

2.—By means of the settling tanks and by such other means as shall be from time to time approved by the Corporation the resulting effluent shall be made:—

(*a*) free from solids in suspension beyond 15 grains to the gallon

(*b*) free from any substance matter or thing which shall or may (either alone or in combination with other matter or liquid, or with the ordinary sewage)

(i.) be injurious to the structure or materials of the sewers or works of the Corporation.

(ii.) be injurious to the sewers or the sewage therein

(iii.) cause or create nuisance either within or without the sewers and

(iv.) be dangerous or injurious to health either within or without the sewers

(*c*) free from any substance matter or thing the discharge of which into the sewers may contravene any public or local Act of Parliament or Rule of Law.

3.—The Owner shall remove as frequently as may be necessary from the settling tanks all solid refuse and solid matter which may be from time to time deposited therein.

4.—Only the effluent from the settling tanks which complies with Regulation 2 shall be discharged into the sewers.

5.—The maximum aggregate daily quantity of effluent which may pass from the manufactory into the sewer shall be agreed between the Owner and the Corporation before any connection with the sewer is made or any works for that purpose are commenced. The size and capacity of the drain for conveying the effluent from the manufactory to the sewer shall be determined by the City Surveyor and shall be such as having regard as well to the agreed maximum aggregate daily quantity of effluent as to the intended inclination of the drain will be necessary to secure that only such agreed quantity shall and may be conveyed into the sewer at a uniform and regular rate of flow throughout the 24 hours of every day.

6.—The Owner shall provide and efficiently maintain a reservoir or receptacle at the manufactory sufficient to hold at least one half the agreed maximum aggregate daily quantity of effluent and shall cause the effluent to pass into such reservoir or receptacle and be thence conveyed by the drain into the sewer.

7.—There shall be constructed and maintained by and at the cost of the Owner at or near the outlet of the drain into the sewer an examination shaft and apparatus so designed as to enable the Corporation or their officers to obtain at pleasure from time to time samples of the effluent discharged into the sewer.

8.—The works shall be constructed and carried out to the satisfaction in all respects of the City Surveyor and shall be at all times subject to these Regulations and the Acts of Parliament (Public or Local) Byelaws and Regulations for the time being in force in the City of Manchester in relation to the subject matter of these Regulations. In particular in the works of excavating for and making and maintaining the drain or anything therein or connected therewith the Owner will adopt such measures and generally carry out the works in such manner as shall be suggested or required by the City Surveyor for ensuring the satisfactory execution of the work for effectually protecting the sewers drains gas and water pipes wires tramlines and apparatus for ensuring perfect stability for the surface of the street and for preventing the complete stoppage of the traffic thereon provided that the fact of the City Surveyor giving or failing to give any instructions or directions respecting the works shall not relieve or exonerate the Owner from any obligations or liability imposed upon him by these regulations or at law.

9.—Any work of removing the pavement and flagging of the street and of restoring and making good the same shall be done by the Corporation at the expense of the Owner and the Owner shall pay any such expense to the Corporation on demand.

10.—The owner shall permit the City Surveyor or any other duly authorised officer of the Corporation to enter the manufactory from time to time and to inspect the condition thereof.

11.—If at any time the works provided for by these regulations or any of them or anything therein respectively shall in the opinion of the Corporation or the City Surveyor be in a dilipidated unsafe inefficient or unsatisfactory condition or if the same shall not be kept and maintained in proper working order or shall not be duly and properly fulfilling these regulations in all respects or if proper arrangements for removing the solids from the trade refuse are not in regular and constant operation it shall be lawful for but not obligatory on the Corporation in addition and without prejudice to their other remedies by statute or contract at the risk and cost of the Owner (after first giving to the Owner one week's notice in this behalf) either to repair reinstate or complete the same or to remove and disconnect the drain from the sewer as the Corporation in their absolute discretion may think fit and to enter upon the property of the Owner for the purpose of executing the necessary works in that behalf. The Owner shall pay to the Corporation on demand the cost to be incurred by the Corporation in any such work of repair reinstatement completion or disconnection such cost to be from time to

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time ascertained and certified by the City Surveyor whose decision shall be final and binding on all parties.

12.—Any costs and expenses which may be incurred by the Corporation and which under these regulations shall be repayable to them by the Owner shall include five pounds per centum for superintendence and shall carry interest at four pounds per centum per annum from and after the expiration of one calendar month after service upon the Owner of a demand for payment of such costs and expenses.

13.—The arrangements contemplated by these regulations do not extend to the reception into the sewers of surface and storm water or of water which has been taken or diverted from a river stream or canal.

14.—The Owner shall enter into an agreement to be prepared by the Town Clerk for securing the due observance of these regulations.

15.—In these regulations the following words have the meanings here assigned to them:—

"Owner" means and includes the owner and occupier for the time being of the manufactory.

"Manufactory" includes any works manufactory or premises in the City of Manchester in which liquid trade refuse is produced.

"City Surveyor" means the City Surveyor for the time being of the City of Manchester.

and words in the singular number include the plural and words in the masculine gender include the feminine.

To the Corporation of The City of Manchester.

I apply for your permission to make a connection from my works situate ____________________ *with the sewer in* ____________________ *Street, in the City of Manchester, for the purpose o carrying the liquid from such works into such sewer:*

The trade or process carried on at such works is that ____________________.

The maximum daily volume of liquids issuing from such works is about __________ *gallons.*

In the event of my application being complied with, I undertake that the foregoing Regulations shall at all times be duly observed by the owner and occupier for the time being of the said works.

The owner and occupier of the works are prepared to enter into an agreement for that purpose, to be prepared by the Town Clerk of Manchester.

The names and addresses of such owner and occupier are:—

Owner ____________________

Occupier ____________________

Signature ____________________

Address ____________________

Date ____________________

14396. You have had no great difficulty in getting people to comply with the conditions that you make?—Practically none.

14397. And you do not think therefore that additional powers are necessary to give local authorities the full powers required to make these conditions?—We did find that difficulties arose in consequence of different chemical products in the sewer combined giving off gases, and last year we applied to Parliament—Dr. Dreyfus was the Chairman of the Committee—and we got powers, and with those powers we think we are comparatively safe.

14398. Your practical experience is that you are able to make conditions which render possible the acceptance of trade effluents into your sewers and that your manufacturers generally are willing to carry out these conditions?—That is so.

14399. The only difficulty that I think you refer to is where the sewer is not large enough to receive the volume of trade refuse?—Where the sewer is not large enough or the works are at a distance from the sewer. Then, of course, we conceive that we are not bound to take the sewage.

14400. Well, it has been suggested to us that in these cases the authority ought to make a bigger sewer; what is your view upon that?—I think the whole cost should not be cast upon the authority.

14401. The whole cost?—I think not.

14402. No; but should the obligation, subject to questions of cost being considered?—The manufacturer paying the cost, for instance, of taking a sewer from his works to our main sewer; if he pays the cost there is no objection to our taking his sewage like other sewage.

14403. The Commission have met with many cases where there are difficulties between the authority and the manufacturer. Some authorities will not receive trade effluents, or they lay down conditions which the manufacturers say are unreasonable, and so on, and there is a question as to whether the law as it stands at present is clear. There seems to be a doubt on the part of some persons whether an authority is or is not compelled to put down a sewer big enough to take trade effluents, and a doubt even if the sewer is big enough if the authority can be compelled to take trade effluents, and it has been suggested to us that it would be proper to alter the law in this direction, to lay the distinct obligation on the local authority to receive trade effluents subject, however, to their having full power to lay down the conditions upon which they will receive the trade effluents. Now, do you think that a modification of the law in the direction of laying a distinct obligation on the local authority subject to their having power to make conditions would be advisable?—Our experience is that the law suffices as it exists at the present time, but I can conceive cases where there may be greater difficulty than exists with us where an alteration of the law might be useful.

14404. (*Chairman.*) Even your own Bill; have you legislated for any such questions as Colonel Harding has been mentioning?—We have had no special legislation upon that particular point.

14405. What was the particular object of your Bill?—The object of the Bill was to deal with matter passing into our sewers generating gases which caused the death of some of the men going into the sewer, and it was to provide against the recurrence of such accidents that we went to Parliament. On that point I think Dr. Dreyfus can better speak, because he was Chairman of the Committee.

14406. Perhaps you would kindly tell us the special object of the Bill?—(*Dr. Dreyfus.*) The special object was to prevent the putting into our sewers all liquids which might generate in conjunction with what there might be in the sewer gases which might be injurious to the health of the workmen of the Corporation who have to go into the sewers for the purpose of cleaning the sewers, or gases which might be injurious to the health of the people whose houses are along the line of such sewers. We had some accidents in our sewers some years ago by which two or three workmen were killed owing to some sulphuretted hydrogen having been generated. How it was generated was not sufficently investigated at the time. No doubt it was due to some acid getting into the sewers and some sulphides which were in the sewers getting into the contact with acid.

14407. (*Colonel Harding.*) Have you met any difficulty with the effluents which were clear when they went into the sewer but which caused precipitation by mixture with other matters in the sewers and so interfered with the flow in the sewers?—I do not think we have met with any serious difficulty from that source.

14408. But probably you can conceive of cases where an effluent might come into a sewer and be free from suspended solids but be the cause of very serious precipitation in the sewers and so on?—No doubt such a thing is possible, but up to the present time I do not think it has caused any serious block in any of the sewers of the Corporation of Manchester.

14409. Then you clearly are of opinion that a local authority ought to have power to deal with all the special circumstances as they arise?—Certainly.

14410. And to make conditions; for instance, the laying down of a rule that suspended solids when taken out would not in all cases be sufficient; it might be required in certain cases to do something more to meet it; the local authority ought to have ample powers to consider all these special circumstances and to lay down the conditions which it thinks to be necessary?—Certainly.

14411. Now, in the event of difficulty arising between a manufacturer and a local authority, do you agree with Sir Bosdin that the existing Courts are ample to deal with the cases, or do you think it would be better to have some special body?—I would prefer to see a special Rivers Board or a special Court instituted to deal with such cases.

14412. Would you as a Court of First Appeal have confidence in your local Rivers Board?—Well, we have not

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any jurisdiction at the present time other than the Police Court.

14413. Suppose for instance there is a difficulty arises between the local authority and a manufacturer as to conditions being reasonable, do you think that an appeal to the decision of the Mersey and Irwell Rivers Board would be received with confidence by both parties?—At the present time, certainly. I have never heard any complaints made against any decision of the Mersey and Irwell Rivers Board.

14414. Do you think that would be a suitable body to appeal to?—Certainly.

14415. If it were considered necessary to have a further appeal from them, I rather gathered from what you said that you thought a Central Rivers Board such as was rather suggested in the first report of this Commission would meet with your approval?—I just want to make myself quite clear. The Mersey and Irwell Joint Committee at the present time do not take any objection themselves, but they take offenders before a Court of Summary Jurisdiction. They themselves do not adjudicate but they take the offenders or whom they think offenders before a Court.

14416. No, but in cases of difficulty do you think that the Rivers Board would be a body which would command confidence if it were given powers of adjudicating in these cases?—I do not know whether the Mersey and Irwell Joint Board, or any other authority of that kind, have a sufficiently judicial mind to give a decision that would be adhered to by the people. They are after all ordinary people, people that have not had any legal training, and I do not know that their decisions would be accepted or would be favoured by the people that they are putting into Court.

14417. Then you would prefer a central body;—Certainly, a central body composed of experts and judges.

14418. And judges?—And judges.

14419. Experts and legal men?—There are not only questions of chemistry, matters that come within the province of the chemist and the engineer, but there are also legal questions.

14420. I suppose if you are to have the judges, it would be better to adhere to the existing Courts?—I should like to have a Court of Jurisdiction which is composed not only of judges but also of experts.

14421. (*Chairman.*) Something like the Railway Commissioners?—Something to that effect.

14422. (*Sir Michael Foster.*) By a judge, do you mean an actual judge or do you mean a person possessing the requisite legal knowledge?—Simply a man of the requisite legal knowledge; that would be quite sufficient without his being a judge if you like.

14423. (*Colonel Harding.*) Would you see any objection to an alteration of the law which while giving ample power to a local authority to make conditions or to refuse to take an effluent if its volume were unreasonably large, would nevertheless lay upon the authority a distinct obligation to receive trade effluent?—I think local authorities ought to receive trade effluents if they are of reasonable volume. If they are of an abnormal volume from one particular place of business, and preparations had not been made at the time when the local authorities laid down their own sewage system, then I think there is a difficulty and an extra cost to which the local authority ought not to be subjected.

14424. Yes, but subject to the consideration of these matters do you see any objection to a distinct obligation being laid by law upon the local authority to receive trade effluents. You know that at present under the Rivers Pollution Prevention Act it does say that they shall give facilities?—Yes.

14425. Well, it is said to us by some witnesses that that is not strong enough, that there ought to be a more distinct obligation?—I think we ought to receive all the trade effluents of the districts which are existing at the present time, but if anyone wants to put up a works of very large dimensions, much larger than local authorities have provided for in their drainage system, I cannot quite see how the local authorities should be put to the expense of remaking the drainage system, and increasing the volume of their sewers.

14426. But even if the obligation was distinctly laid upon the authority to receive trade effluents they would have the power in special cases of that kind to say, We do not think it is reasonable in this specific case to ask us to do it, and then you would have to settle that by some power of appeal to some other Court or some other body?—I think they ought to receive the trade effluents in a reasonable way, of their district.

14427–8. Then in short you are in favour of local authorities being compelled to take trade effluents subject to conditions?—No; certain conditions, certainly.

14429. Is that your view also Sir Bosdin?—(*Sir Bosdin Leech.*) My view is that as a manufacturer, when he discharges a large quantity of effluent does so for his own profit, though the authority ought to take the material, yet there should be an adjudication as to the cost of dealing with it.

14430. Then do you think it is possible to lay a special rate?—I think there are circumstances that would demand this course, either because of the effluent being exceedingly costly to deal with, or because of its volume. A manufacturer should not get rid of his effluent without any cost to himself, and throw the burden of dealing with that effluent on the district at large.

14431. You think the local authority ought to have the power to say to a manufacturer "Yes, we will take your effluent subject to your carrying out preliminary conditions, and subject to your paying so much for the extra expense that we shall be put to in dealing with it"?—That is my view, that they ought to take it, but there are other considerations which should be gone into as to the cost of dealing with it.

14432. Mr. Fowler has told us that h thinks it is possible to assess that cost?—That is so.

14433. (*Sir Michael Foster.*) It has been represented to us, Sir Bosdin, that the feeling is that the law as it at present stands is rather in favour of the local authority refusing to take in the trade refuse, and it is recommended that certain changes should be made in the law so that *prima facie* the local authority should receive the refuse subject to the local authority having power to lay down certain conditions. I understand that both you and Councillor Dreyfus are rather in favour of the law being amended in that direction?—I should like to qualify my answer if necessary. In many places the existing sewer is not of sufficient size, and therefore I do not think that because a man goes and builds a place to suit himself where he gets cheap water or cheap labour that the whole district should be saddled with the cost of putting new sewers down to accommodate that special manufacturer.

14434. That would be a special case, but it is rather with regard to the general aspect of the law. The general aspect of the law is now stated to favour the local authority in refusing to accept the trade sewage. Do you approve of a change in the law which would just remove that and say that *prima facie*, the local authority should admit the trade refuse. It is for the local authority to show reason why it cannot and to put down such conditions as it may think desirable?—I quite think that they ought to put down conditions if they are obliged to take the trade refuse.

14435. Should there be just such a change in the law as would throw the onus of refusing on to the local authority, whereas now the difficulty is in the other direction?—In our district we have not experienced any necessity of that kind.

14436. No, but I mean treating the law generally over the land; from your experience what do you say, Councillor Dreyfus?—(*Councillor Dreyfus.*) I should say the local authorities ought to be compelled to take that trade effluent in their midst provided that conditions, safety conditions that they lay down, are obeyed by the manufacturer, because after all this country lives on its trade, and we must put no obstacle in the way of competing much more with the foreigners than we have already.

14437. Then you are in favour of the law being changed in that direction?—Very strongly in favour of that.

14438. (*Major-General Carey.*) And of the sewers being made large enough to take that refuse if necessary?—Certainly, if necessary.

14439. (*Sir Michael Foster.*) What powers have you taken under your Act to protect your workmen—what steps?—The additional powers that we have taken are simply in our Act of 1902 to prevent the introduction "of any solid matter, suspended matter, mud, chemical or manufacturing, or trade or other refuse (inclusive of vapours or gaseous matters), or any steam, condensing water, heated water, or other liquid (such water or other liquid being of a higher temperature than one hundred and ten degrees Fahrenheit) into a sewer whether alone or in combination with other matter or liquid, and

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whether directly or through any drain or channel communicating therewith either does or may cause a nuisance." I shall hand you that in; the whole of our powers are stated there.

EXTRACTS FROM ACTS OF PARLIAMENT.

The Public Health Act, 1875.

Power of owners and occupiers within district to drain into sewers of local authority.

21.—The owner or occupier of any premises within the district of a local authority shall be entitled to cause his drains to empty into the sewers of that authority on condition of his giving such notice as may be required by that authority of his intention so to do, and of complying with the regulations of that authority in respect of the mode in which the communications between such drains and sewers are to be made, and subject to the control of any person who may be appointed by that authority to superintend the making of such communications.

Any person causing a drain to empty into a sewer of a local authority without complying with the provisions of this section shall be liable to a penalty not exceeding twenty pounds, and the local authority may close any communication between a drain and sewer made in contravention of this section, and may recover in a summary manner from the person so offending any expenses incurred by them under this section. (*a*.)

The Rivers Pollution Prevention Act, 187.

Sanitary authority to afford facilities for factories draining into sewers.

7.—Every sanitary or other local authority having sewers under their control shall give facilities for enabling manufacturers within their district to carry the liquids proceeding from their factories or manufacturing processes into such sewers:

Provided that this section shall not extend to compel any sanitary or other local authority to admit into their sewers any liquid which would prejudicially affect such sewers or the disposal by sale, application to land, or otherwise of the sewage matter conveyed along such sewers, or which would from its temperature or otherwise be injurious in a sanitary point of view:

Provided also, that no sanitary authority shall be required to give such facilities as aforesaid where the sewers of such authority are only sufficient for the requirements of their district, nor where such facilities would interfere with any order of any court of competent jurisdiction respecting the sewage of such authority.

The Public Health Acts Amendment Act, 1890

Injurious matters not to pass into sewers.

16.—(1) It shall not be lawful for any person to throw, or suffer to be thrown, or to pass into any sewer of a local authority or any drain communicating therewith, any matter or substance by which the free flow of the sewage or surface or storm water may be interfered with, or by which any such sewer or drain may be injured.

(2) Every person offending against this enactment shall be liable to a penalty not exceeding ten pounds, and to a daily penalty not exceeding twenty shillings.

Chemical refuse, steam, &c., not to be turned into sewers.

17.—(1) Every person who turns or permits to enter into any sewer of a local authority or any drain communicating therewith—

(*a*) Any chemical refuse, or

(*b*) Any waste steam, condensing water, heated water, or other liquid (such water or other liquid being of a higher temperature than one hundred and ten degrees of Fahrenheit),

which, either alone or in combination with the sewage, causes a nuisance or is dangerous or injurious to health, shall be liable to a penalty not exceeding ten pounds, and to a daily penalty not exceeding five pounds.

(2) The local authority, by any of their officers either generally or specially authorised in that behalf in writing, may enter any premises for the purpose of examining whether the provisions of this section are being contravened, and if such entry be refused, any justice on complaint on oath by such officer, made after reasonable notice in writing of such intended complaint has been given to the person having custody of the premises, may by order under his hand require such person to admit the officer into the premises, and if it be found that any offence under this section has been or is being committed in respect of the premises, the order shall continue in force until the offence shall have ceased or the work necessary to prevent the recurrence thereof shall have been executed.

(3). A person shall not be liable to a penalty for an offence against this section until the local authority have given him notice of the provisions of this section, nor for an offence committed before the expiration of seven days from the service of such notice, provided that the local authority shall not be required to give the same person notice more than once.

The Manchester Corporation (General Powers) Act, 1902.

Provisi[on] as to d[is]charge [of] certain matter[s into] sewers.

21. Where in the opinion of the Corporation the introduction of any solid matter, suspended matter, mud, chemical or manufacturing, or trade or other refuse (inclusive of vapours or gaseous matters), or any steam condensing water, heated water, or other liquid (such water or other liquid being of a higher temperature than one hundred and ten degrees Fahrenheit) into a sewer whether alone or in combination with other matter or liquid and whether directly or through any drain or channel communicating therewith either does or may cause a nuisance or involve danger to the health of persons entering the sewers, or others, or is or may be injurious to the structure of materials of the sewers or works of the Corporation, the Corporation may by order absolutely prohibit from a date to be named in such order, not being earlier than fourteen days from the service of such order, any such matters or matter being caused or permitted to fall, flow, or enter or to be carried or washed into any sewer either directly or indirectly.

The Corporation shall cause a copy of any such order to be served upon any person who may in their opinion be acting in contravention thereof, and if any such person dispute the reasonableness of any such order as applicable to himself, or any works or premises under his control, such person may appeal to a Stipendiary Magistrate for the city, who shall appoint a referee to determine the reasonableness thereof, and any such referee may determine either that the said order ought not to be enforced as against the objector or that it ought to be enforced either with or without modification or conditions, and may by his award determine that the person objecting should have reasonable time allowed to execute any works or any alterations on his premises which may be necessary in order to prevent the introduction of the matter into a sewer, and the costs of the award and determination and the costs of the parties thereto shall be in the discretion of the referee.

Any person who shall fail to comply with the terms of any such order after service thereof upon him or in the event of an appeal to a referee with the determination of the referee shall be liable to a penalty of not exceeding twenty pounds for every such default and to a daily penalty not exceeding five pounds for every day on which the default continues after conviction thereof.

The Corporation shall in their discretion have the power of constructing within any manufacturing premises at the cost of the Corporation, and without any liability on their part for compensation in respect thereof, an inspection chamber or chambers accessible to the Corporation officials at all times for the purpose of ascertaining the nature of the discharge from such premises into the sewers of the Corporation, and the Corporation or any of their officers specially authorised in that behalf in writing may at any time enter any such premises for the purpose of examining the nature of the said discharge and of taking samples thereof.

Any person who shall refuse to permit any such officer, after production of his authority, to enter into any premises, or shall obstruct any such officer in carrying out his duties under this section shall be liable to a penalty of not exceeding twenty pounds.

Nothing in this section shall be deemed to take away or affect any power of the Corporation to take proceedings under any other Act.

14440. (*Chairman.*) You considered the question, and thought that Section 17 of the Public Health Amendment Act of 1890 was not sufficient?—We thought it was not sufficiently clearly defined and we really tried to get this point more clearly defined, so that we could get an easier conviction if it came into a court. You see we are proceeding by making an order, and any man against whom we make an order can then appeal just in the same way as the local County Council do.

14441. (*Sir Michael Foster.*) The clauses that you introduced there are to facilitate you in a court of law?—Yes, to make our position easier against any delinquent.

14442. (*Sir William Ramsay.*) Would you have a special court for the purpose, or merely something like the

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(*a*) In the case of Peebles *v.* Oswaldtwistle Urban District Council, it was held that this clause would not authorise the passing into the sewers of liquids injurious to health [1897] 1 Q. B., 392.

naval court, where there is a nautical assessor acting in connection with the judge?—I should like to have that court that I have mentioned, a court composed of an expert chemist and an expert engineer, and with a gentleman who may have some legal knowledge. I do not know the working of the naval courts, so I am not in a position to say.

14443. The working of the naval court is that the ordinary judge who superintends is assisted by two nautical assessors, persons with special knowledge of shipping law and nautical customs. They advise him. It is the only case in which a judge has actually a permanent staff of assessors with special knowledge?—These assessors in that court are exactly like experts that I mean to be in this court.

14444. Exactly?—Well, I think we would be quite at one.

14445. (*Major-General Carey.*) Sir Bosdin, have the manufacturers whose trade refuse has always been admitted into the sewers since they were coupled up with your own system been as ready to comply with your regulations as those manufacturers who are seeking to be admitted for the first time?—(*Sir Bosdin Leech.*) The manufacturers, who I may add had practically got the right to go into the old sewers, have been allowed to couple up, and they have consented to the local conditions existing, that is to say that they could not put anything in that helped to damage the structure of the sewer, that caused silting of the sewer, or send down any material tnat destroyed or affected the vegetation in case we wished to deal with the effluent sewage at the outlet. They were a small body practically, the larger body coming in since. The action of the joint Rivers Board caused the latter to avoid going into the river and come into our sewer, and the newcomers of course have been dealt rather more strictly with than those who by precedent went into the sewers before.

14446. There were no conditions made when the trade refuse effluent drains were connected up with your sewers?—No, except these under the Public Health Act, which prohibited matters going into the sewers which would be detrimental.

14447. (*Sir William Ramsay.*) Mr. Fowler, may I ask you a question as regards dye water. I see you say the dyers and bleachers turn some 600,000 gallons a day into the sewage system. That discolours the water very considerably, I suppose; it discolours the sewage?—(*Mr. Fowler.*) Yes, in some cases certain of these dyers treat their waste by chemicals and settlement before it comes into the sewer, or they mix their various effluents and pass them through a tank, whereby a certain amount of decolourization and settlement is effected, and consequently a very large bulk of this liquid is not excessively coloured. But there are at the same time large volumes of waste dye water which is somewhat highly coloured and which cannot be removed by ordinary chemicals, certain aniline dyes and so on are unaffected by the precipitation process, but are finally destroyed on going through the bacteria beds. The final effluent, at any rate from the second contact, is always perfectly free.

14448. Are destroyed?—Yes.

14449. (*Sir Michael Foster.*) With a great deal of colour to begin with in the crude sewage?—Yes, there is a good deal in the crude sewage; that might be quite yellow or pink occasionally, as the case may be, but it will come out all right eventually from a second contact, not in the first.

14450. Diminished by the first, I suppose?—Diminished by the first, oh, yes.

14451. (*Sir William Ramsay.*) Do you insist upon the manufacturer taking out grease, that is to say cracking their sud, and the bleachers removing their dye stuffs as far as possible from their effluents before they reach your sewers?—Yes, we ask them to put down settling tanks. Of course the matter is in process of going on in Manchester, you see. There are firms I have in my mind, for instance, who used to use settling tanks when they had to go into the river, and have given them up now that they are turning the stuff into the sewer, but I have warned them that their turn will come and we shall have to deal with them under our regulations. We have a regulation which says that not more than 15 grains per gallon of suspended matter shall be allowed in. Taking that as a rough approximation to what is reasonable, we should approach the people who turn in large quantities of suspended matter, on the ground of their tending to silt up the sewers. You will notice that the words "suspended matter" occur in our new powers. I think that is a new word. There are one or two differences of this sort which were meant to cope with cases such as these.

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14452. (*Sir Michael Foster.*) Which clause is that in your Act?—It is Clause 21 of the Manchester Corporation (General Powers) Act, 1902. The 15 grains occur in our regulations for the admission of trade refuse. These regulations are drafted so as to contain the requirements of all the various Acts. (*Sir Bosdin Leech.*) You were mentioning about a case of dyers. I can give you a concrete case if you like which has been dealt with in our immediate neighbourhood:—A manufacturing firm, to economise cost, determined to bleach and dye their old linen and cotton yarn. By damming up they utilized the water in an adjacent brook, and then turned the effluent into it again lower down in a most vile state. This roused the local authorities, and a prosecution was threatened. The manufacturers claimed the brook as their natural outlet, and being the only large employers of labour threatened to remove their business if they were interfered with. Eventually the firm sunk a well 300 feet deep and ceased to alter the level of the brook, and they put down two tanks filled with cinders to be used alternately. On the top of the cinders are slates. Each tank holds a week's effluent. At the end of each tank the sludge (about 14 ins. deep) from the land not in use is emptied by scoops from off the slate bottom. This sludge is allowed to solidify on a midden, and containing as it does a large amount of saccharine matter from the flax and lime from the bleach works, is found to be a most excellent compost, and is used in place of stable manure which would cost at least 5s. per ton. Since the dispute the district has been sewered and the effluent which is coloured but contains little matter in suspension, is allowed to enter. Both the local authorities and the manufacturers are satisfied, and the latter admit that they have gained by the changes they have made.

14453. (*Sir William Ramsay.*) I would like to ask Mr. Fowler's opinion on another matter which is not referred to here. Does Mr. Fowler think it would be possible to establish a set of persons similar to the Inspectors under the Alkali Act to deal with sewage generally and with trade effluents and indeed with the condition of the rivers?—(*Mr. Fowler.*) All over the country?

14454. All over the country?—I should think so. Personally, I feel very strongly with our Chairman and Dr. Dreyfus that some such Board--Central Board--should be established, a Board moreover, I should say, which would not only exercise powers of inspection and of control, such as the inspectors under the Alkali Acts exercise, but if it were possible should act in some sort as an Advisory Board. I had in mind the Massachusetts State Board of Health, where authorities or manufactures have schemes and come before this Board to have them criticised, criticised not simply according as to whether they fulfil certain regulations, but criticised as to whether they are workable and practicable, and if this Board had a number of trained experts upon it, and a large staff of inspectors, it seems to me the whole thing could be co-ordinated, and a very great reform might occur. I notice for instance I am constantly having deputations to the Manchester sewage works from small authorities who are wrestling with the sewage problem, and they see what we are doing and they go back and think that they must do something similar, whereas I tell them sometimes that they will probably see nothing at Manchester which is any good to them, because their conditions are wholly different, and it is quite impossible for the local authorities to possess the necessary breadth of information which shall give them the very best scheme for their peculiar conditions, and if, without any very great expense it would be possible for such people to furnish all the local statistics, which their local surveyor could readily do, and submit it to some such Central Board, which would be absolutely apart from any local interests it seems to me that a very great benefit would accrue.

14455. (*Sir Michael Foster.*) Do you mean that the local people should state what their wants were, and that the Board should sketch out the way in which they should be met?—I do not say necessarily that it should sketch out; they themselves must sketch out, they would have enough capacity to sketch out a scheme, but it would be submitted for criticism to the Board.

14456. Whether it was the best scheme for the locality?—For the locality; and in the same way any question of dealing with trade effluents as regards their

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entry to the sewer or to the river might be dealt with in that way.

14457. (*Sir William Ramsay.*) And of course the Board would have Inspectors whom it could send to such localities to say what the actual conditions were?—Certainly.

14458. Do you think it would be advisable to make this a part of the duty of the Board which works under the Alkali Act, and to increase the number of Alkali Inspectors, and add this to their duties?—Well, a man may know a great deal about alkali works, and know very little about sewage.

14459. But they learn. They begin by knowing very little about the trade and they learn?—It is simply a question whether they would have the time to attend both to the air and the waters under the earth as well.

14460. (*Sir Michael Foster.*) There is quite enough in sewage to occupy the whole time of one man?—It seems to me so.

14461. (*Sir William Ramsay.*) The only thing is that the machinery already exists under the Alkali Act, and if the number of Inspectors were increased in order to deal with sewage and the sewage problems it might save making entirely new machinery?—Well, of course that is a question rather for the Government to consider as to the system of working.

14462 (*Mr. Stafford.*) Would there be sufficient work for such a Board as that to do?—Oh, I think so.

14463. Permanently?—I fear permanently because there are always fresh conditions arising, unfortunately.

14464. So many things get settled in time by decisions?—But the processes still go on and you want a staff of inspectors to keep the work in order, just as you want them to keep the alkali works and others in order. It seems to me their duties might alter somewhat with time; there might not be so many new cases to adjudicate upon, but then their duties would be more of controlling and seeing that the law was carried out, I take it.

14465. (*Colonel Harding.*) Might these duties of controlling be better carried out by a local body such as your Joint Rivers Board?—Well, if a local body be sufficiently strong it may come eventually to a question of finance. If the Government could be behind it sometimes it is possible to have a greater staff, for instance, of inspectors, and then it is possible that these local authorities such as the Mersey and Irwell Board might be in touch with the central authority.

14466. With the central department?—Yes, and work in harmony with them so that the machinery would be simplified.

14467. So that the central body would not have to keep a large staff of inspectors to supervise the various works, it would be more a body for final reference?—To be sure, yes.

14468. (*Dr. Burn Russell.*) Have you followed up the ultimate practical results of any of those deputations to which you have referred, from small places who report to the body they represent; I mean do you know as a matter of fact that the local authorities make very serious mistakes?—I do not know that I could offhand think of any serious mistakes in the actual construction of their works. I think that possibly in many towns it might be improved. The mistake in general unfortunately is that they build their works and then leave them without proper control, and then they go wrong.

14469. Yes, I suppose that is the universal experience. You may make any installation you please, strict supervision is necessary on the part of some independent supervising body?—And also on the part of the authority themselves. I should like to emphasise that very much, that there is a great deal of money being spent in capital expenditure, and there is no really adequate supervision of the works when they are laid down, and so they do not in some cases succeed as well as they ought to do.

14470. I think in dealing with the case of nuisances arising from individual manufacturing processes that local authorities generally find it expedient not to commit themselves to any specific method of removing a nuisance, but to exercise pressure and to leave the authors of the nuisance to take the best advice they can and act on their own responsibility. Do you not think that something of the same experience would attend the action of any body that would relieve the local authorities of the responsibility, which ultimately must rest upon them, of dealing with their own sewage questions?—I am not quite sure whether I follow.

14471. I do not know whether you know, but in dealing with the action of local authorities for the removal of nuisances it is a general principle that their officers do not commit themselves to any specific method of removing the nuisance, and I should apprehend that if a central body relieved the local authority by such an advisory function as you suggest, of the responsibility which must be with them ultimately of dealing with their own sewage questions, the result might be in some cases not exactly what was expected?—Possibly so, but I take it that it would not relieve them of the responsibility of dealing with it. That was not exactly my idea, but rather that it would be a useful check upon any scheme that was submitted. Of course, naturally at the present time, the Local Government Board acts to some extent in that way; as a check on schemes which are not quite for the best, but of course we know that in such cases there are certain regulations according to which they act which possibly might with advantage be made somewhat more elastic so as to deal with the particular conditions of each place.

14472. The Local Government Board of course take advantage of applications for loans to go into the merits of the question?—To be sure, yes.

14473. I just wish to suggest the one impression on my mind that it is best as a rule to leave l cal authorities even at the risk of a little floundering to work out their own problems?

14474. (*Sir William Ramsay*) I do not know whether Mr. Fowler knows that the Inspectors under the Alkali Act give gratuitous information, without accepting any responsibility for it, and the terms on which they are with the manufacturers are most excellent?—I believe so; well, something of that sort is what I had in my mind. It has just come into my mind now while speaking that there is a very large number of small works for very small districts up and down the country which cannot afford in each case skilled advice, and that is a serious problem. I believe the Commission are fully aware of the existence of many of these small places of just a few hundred inhabitants and if they could all be centralised under a central supervision and samples taken by a central body or whether they might join of course and make such a central control office for themselves and this should be in touch with this Central Rivers Board, but some system of some kind is certainly necessary if these works are to go on satisfactorily.

14475. (*Dr. Burn Russell.*) Those small bodies are small local authorities?—Urban District Councils.

14476. With limited finances, and limited mental area, and limited everything?—And limited everything.

14477. Not fit to perform the functions of a local authority at all in fact?—Well, I would not say that, not at all, the works are all right you see, only it is perfectly impossible for instance for a small village to pay a guinea a sample to a chemist to have it analysed or anything like that.

14478. (*Mr. Stafford.*) You want a central department in fact that will collect information and advise small bodies as to how to deal with their particular problems?—I think so, yes, that the information that this central body has shall be at the disposal of anybody who needs it. As I say, I have in mind the Massachusetts State Board of Health. (*Sir Boadin Leech.*) Might I also point out in going across the water that in Canada there is a most useful institution experimenting and advising agriculturists throughout the country.

14479. (*Chairman.*) What is it named?—I think it is the Agricultural Bureau.

14480. (*Sir William Ramsay.*) There is a number of experimental farms?—Oh, yes.

FORTY-NINTH DAY.

Monday, 20th October, 1902.

BIRMINGHAM.

PRESENT:

Colonel T. W. HARDING, J.P. (*Chairman*).

Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E. | Mr. T. J. STAFFORD, F.R.C.S.I.
Dr. JAMES BURN RUSSELL.

Mr. F. J. WILLIS, *Secretary*.

ALSO PRESENT—

Dr. A. C. HOUSTON. | Mr COLIN C. FRYE.

MINUTES OF EVIDENCE TAKEN ON THE BIRMINGHAM SEWAGE WORKS AT SALTLEY.

Mr. J. D. WATSON, Assoc. M.Inst., C.E., called; and Examined.

Mr. J. D. Watson, A.M.INST., C.E.

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14481. (*Chairman.*) What is exactly your title?—I am Engineer and General Manager to the Birmingham Tame and Rea District Drainage Board.

14482. Will you tell us just what is the population for which those works provide drainage?—The population is 811,000 altogether. Birmingham, which has a population of—I will give you the last census figures—522,182.

14483. That is 1901?—That is 1901. The borough of Aston has a population of 77,310; the borough of Smethwick a population of 54,560; the urban districts of Handsworth, 52,921; King's Norton, 50,000; Erdington, 16,366; and the Borough of Sutton Coldfield, 14,264. In addition, we have several villages. I reckon the population of the villages altogether will be about 5,000. Then the increase of the population in the district between 1891 and 1901 was equal to 2 per cent. If I add that percentage we have a population of rather more than 811,000 people.

14484. (*Dr. Russell.*) 2 per cent.?—Yes.

14485. (*Chairman.*) What is the normal dry weather flow of your sewage as received at the works?—Here at Saltley we receive a flow of about 22,000,000 gallons, but between this point and our works at Tyburn we receive an additional 3,000,000 gallons.

14486. Then do I understand that 25,000,000 gallons is the normal dry weather flow of sewage as received at your works?—Yes, roughly, 25,000,000 gallons.

14487. And I think at the time of our last visit you were treating the whole of your sewage by the system of chemical precipitation?—That is so.

14488. Wholly by precipitation by lime?—By lime. We employed about 9 grains per gallon of sewage.

14489. What changes have taken place since our last visit?—Since that time the lime-precipitating process has been entirely abandoned, and we now have in use septic tanks capable of containing 7,263,180 gallons of sewage. These septic tanks enable us to give the sewage a rest of about eight hours.

14490. You used, no doubt, your old settling tanks as far as they went?—Oh, yes.

14491. And have you constructed others in addition?—We have constructed others in addition.

14492. Then your total capacity is about one-third of your normal flow?—More, if you take both the septic tanks and what we call the roughing tanks together.

14493. By roughing tanks you mean grit tanks?—Grit tanks and precipitation tanks. We have the 5 large roughing tanks you see each divided into three bays, and capable of containing 5,610,150 gallons. The first day of the tank catches the heaviest portion of the solids.

14494. Road detritus?—Road detritus and other heavy substances. In the second bay you have a considerable amount of both organic and inorganic matter, and in the third bay you have slime or sludge. Road detritus, etc., contains 50 per cent. water, and sludge 90 per cent. water.

14495. Then do I understand you are working these roughing tanks in a series of three compartments?—No. All our sewage passes through the big roughing tanks from the one great outfall sewer. We have four of these working at one time; the fifth is generally in process of being emptied, and from the roughing tanks the water goes to the septic tanks, and all the septic tanks are working together.

14496. How do you mean together—do you mean that the flow is from one to the other, or that each one is working independently?—Each one is working independently.

14497. (*Secretary.*) Working in parallel?—Working in parallel.

14498. (*Chairman.*) Then what takes place is that you first of all pass your sewage through these roughing or grit tanks, and then it passes through septic tanks working independently?—That is so.

14499. And the stay in the septic tanks is, roughly, eight hours?—That is so.

14500-1. Is that sufficient with your sewage to fully develop septic conditions?—It is; it is a sufficient stay. I ought to add, that after the sewage passes through the septic tanks it enters a large conduit, 8ft. in diameter, which conveys the bulk of the sewage right down to the extreme limit of our property, and that conduit is to all intents and purposes a closed septic tank, so that we have a further septicisation of the sewage after it leaves our works.

14502. But what would be the stay in the conduit; it would be very short, would it not?—About six hours, perhaps.

14503. So much?—The conduit is capable of containing more than 6,000,000 gallons of sewage. At the extreme end, the sewage has therefore undergone an anaerobic action for 14 hours, but at this end there would be comparatively a very short septic treatment, perhaps less than an hour in addition to the treatment in the open septic tanks.

14504. Then before we pass on from the septic tanks we understand that with septic conditions you might possibly get scum; is that so?—We do.

14505. And you get ample development of gas?—That is so.

14506. And how long has this system been at work?—I can show you some tanks which have been in operation for $3\frac{1}{2}$ years, but generally for two years.

14507. Then I take it that in that time they have been to some extent emptied, have they not?—They have not.

14508. Never been touched?—Not at all.

14509. Then the necessity for emptying them has not arisen?—It has not yet.

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14510. What amount of suspended solids passes off with the effluent?—I will give you that. I have prepared a statement that will let you see that exactly.

BIRMINGHAM TAME AND REA DISTRICT DRAINAGE BOARD.

	Grains per gallon.	= Annual deposit of cube yds. of sludge containing 90% of water.
Suspended matter in crude sewage - - - -	47·3 - -	300,700
Suspended matter in septic tank effluent as it leaves the tanks - - -	17·1 - -	108,700
	30·2 - -	192,000
Of this quantity of suspended matter (30·2) there is pumped and lifted from the roughing tanks by steam grab -	24·0 - -	152,000
The balance equals amount of liquefaction taking place in the septic tanks	6·2 - -	40,000

14511. It will be interesting if you have the average analyses of the crude sewage as it leaves you?—I can let you have that too.

14512. Give us an average analysis?—Yes.

14513. Is this a paper which you can hand in?—I can. The suspended matter in the crude sewage is equal to 47·3 grains per gallon. The suspended matter in the septic effluent is equal to 17·1 grains per gallon. The total amount of suspended matter pumped out of the precipitation and grit tanks and disposed of is 24·0 grains per gallon. That left 6·2 grains per gallon solid matter disposed of by septic action.

14514. Disposed of?—Liquified or converted into gas.

14515. Would you mind giving those last figures again? You said the difference between them was 30. From that point, please?—Yes, the difference between 47·3 crude sewage and 17·1 septic effluent is 30 grains per gallon got rid of in the precipitation and septic tank.

14516. That is deposited in the roughing tanks?—Roughing tanks plus septic tanks.

14517. Then what passes forward to the septic tanks proper?—6·2.

14518. Grains?—Grains per gallon.

14519. You were telling us that was disposed of?—Yes, in the sense of being converted into water or gas.

14520. It would be the difference between 24 and 6. In the septic tank you get rid of 17?—Seventeen passes away with the septic effluent.

14521. So that all that is left in the septic tank is 6·0?—Yes.

14522. Your last remark does not make it quite clear, does it? 6 grains is left in the septic tank?—Yes.

14523. And that has been going on for over three years?—But I do not want you to understand that is left in the septic tank.

14524. Has been left behind in the septic tank; it has really been left behind?—Yes, I understand.

14525. That has been going on for over three years?—Yes; that is so.

14526. And you have not as yet found any necessity to clear the tanks of accumulated sewage?—No.

14527. Do you foresee from the amount of sludge now in the tanks that it will at an early date be necessary to remove any?—No.

14528. Do I gather, then, that you think the 6 grains per gallon, which is left in the septic tank, is in effect dissolved?—That is so.

14529. The whole of it?—The whole of it.

14530. What is the amount of sludge in the tanks now? You have some, I suppose, now?—Practically nothing at all. We have not more than an inch of slimy stuff at the bottom. That is mostly, I should think, ferrus-sulphide, or something of that sort.

14531. We will go back for a moment to the roughing tanks. The great bulk of your suspended solids is evidently disposed of by the roughing tanks?—That is so.

14532. Those are frequently emptied?—Yes.

14533. Can you give us any idea of the amount of sludge produced by day?—About 400 tons per day.

14534. That would be a great deal less, would it not, than in the old days of chemical precipitation?—About a half.

14535. And how do you deal with the sludge?—Formerly we lifted it by means of dredger buckets, and sent it down in wooden shoots or troughs to the land in the immediate neighbourhood of the precipitating tanks, where it was spread over the fields in great lagoons, and afterwards dug in by hand; now we send it down by means of compressed air in a 9in. main $3\frac{1}{2}$ miles in length. That main is fitted with special branches at every 200 yards, to which we attach, where required, a portable pipe, a steel pipe; the sludge is then conveyed on to the land wherever we find it most convenient.

14536. Pretty much as we saw it dug in when we were here before?—No, sir, in quite a different way. At that time they had acres of lagoons. We would have sometimes many acres of sludge lying exposed on the surface. Now it is difficult to see the sludge at all. The sludge is there, nevertheless, but it is put in the form of long trenches lying parallel to each other, so that unless you stand looking at the end of the trenches you cannot see the sludge in them. We cover the sludge by sprinkling earth on the top through an ordinary screen. The earth is thrown right over, and the sludge is buried in that way. During hot weather we can do that within a day—in two days at the very most. In weather like this we would not do it within a week, sometimes longer. Sometimes when the earth is very wet it is very difficult to get earth on to it, and we find the better way is to leave the sludge perfectly undisturbed.

14537. Does ordinary putrefaction arise in those cases where it has to be left some time in the trenches?—I may say it does at times.

14538. Does any nuisance arise?—No, I think not.

14539. Not appreciably?—Not appreciably. You will see it to-day, perhaps, in its very worst state—in its very worst state—because we have had wet weather for a considerable time. The land has not been allowed to dry; we are also on perfectly fresh ground that has never been sludged before, and it is of a wet, marly nature; so that at present we are in considerable difficulty. I shall be able to show you how we proceed, and how we have been going on for some time.

14540. Then we are to take it that here in Birmingham considerable advantage has been found from the abandonment of the chemical process previously used for precipitation?—I think there can be no doubt about that.

14541. You now have unassisted precipitation of the part of the sewage which goes forward into the septic tanks, and is there decomposed, and that decomposition goes to some extent towards reducing the total volume of the sludge?—That is so.

14542. Then the effluent from those septic tanks contains still a considerable amount of suspended solids?—Yes.

14543. Probably in a finely divided form?—In a finely divided form.

14544. How does that differ from what you used to deal with, from your chemical precipitation? Probably with your chemical precipitation you had more thorough settlement, and less solids in the effluent?—We had; that is precisely the condition.

14545. To what extent?—When we limed the sewage, the average analysis was as follows: Dissolved solids, 138·0. I had better give it to you after it has passed the septic tanks.

14546. As you take it away to put on the land. The especial point I wanted was, how much suspended solids did it contain?—16·3.

14547. So much as 16·3?—Yes.

14548. Then the difference between that and what you are now turning out from your septic tanks is quite small, because now you have 17 grains per gallon, and this is 16·3 parts in 100,000?—When I said just now 16·3, I meant parts per 1,000.

14549. The 17 grains was per gallon?—Yes.

14550. Then it would contain——?—About 24·5. I give it here as 24·5 parts per 100,000.

14551. So that to compare the two, one must compare 16 with 25?—One must compare 16 with 25.

Mr. J. D. Watson, A.M.INST., C.E.

20 Oct. 1902.

ANALYSES OF EFFLUENTS FROM PRIMARY AND SECONDARY PRECIPITATION TANKS AFTER LIME TREATMENT.

RESULTS EXPRESSED IN PARTS PER 100,000.

Dissolved Solids.	Suspended Solids.	Free and Saline Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrogen as Nitrates and Nitrites.	Oxygen absorbed.		Alkalinity.	Total Nitrogen.		Nature of Sample.
						Unfiltered.	Filtered.		Unfiltered.	Filtered.	
138·0	16·3	3·46	1·00	22·9	0·48	10·91	8·17	—	6·71	6·56	Roughing tanks after liming, 1900.
133·2	4·2	3·79	0·97	19·8	0·58	9·52	—	26·4	5·70	—	Finishing tanks after liming, 1900.

Mr. J. D. Watson, A.M.INST., C.E.

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14552. Of course, in this respect the effluent is more difficult to deal with than was the effluent from chemical precipitation?—Well, I do not find it so. I thought when I first tried it there might be a very considerable amount of difficulty in the way, and I was afraid to put so much suspended matter into our main conduit, knowing that it would be a serious matter to clean an 8ft. diam. sewer which is in constant use, but instead of that being the case I have found that there is no silting; indeed, I have reason to believe that the conversion of the sewer into a septic tank, so to speak, has been the means of getting rid of a certain amount of existing sludge.

14553. The sewer, I suppose, is the conduit you alluded to before?—Yes. I now have less, and I attribute that to the septic action which is constantly going on.

14554. Do I understand that you have less going out of the conduit than goes into the conduit?—No. We have three big sewers going into the conduit. One brings down upwards of 2,000,000 gallons a day; another brings down about three-quarters of a million, and in addition there are one or two small sewers. We have no precipitation tanks in connection with them, and the sawage and the silt and everything goes right into the big conduit, and opposite each junction there has been for years a deposit, which has to be removed by manual labour. Since I abandoned the use of lime I have had an actual reduction in the quantity of sludge deposited at those junctions.

14555. And that you attribute to the septic action in the conduit?—That I attribute to the septic action in the conduit.

14556. Then we may take it generally that you have not found effluent from the septic tanks more difficult to deal with by your further processes than you did formerly the chemical precipitation effluent?—That is so.

14557. Before we ask you about further treatment, let me ask what trade effluents go into your sewers. I suppose in Birmingham you have a great variety of trades, and that a great many manufacturers are connected up to the sewers?—That is so. I have here a statement which shows that into our Rea main sewer we have 800 carboys of hydrochloric acid discharged from galvanising works, 108 carboys from steel tube and wire works, 128 carboys from rolling mills, 124 carboys from brass foundries, and that gives a total in the Rea main of 1,160 carboys.

14558. The answer I was endeavouring to get from you was one of a more general character. We may take it, may we not, that trade effluents of various kinds come into your sewer, and represent a very considerable volume of what you have to deal with?—Yes, that is so.

14559. Can you give us roughly the proportion between trade effluents and domestic sewage—quite roughly?—Somewhere between a quarter and a third, I should say, of the whole.

14560. Is it from a great variety of manufactures, or is there a preponderance of any one effluent?—A great variety, but chiefly connected with the metal trades.

14561. Is there much pickle or acid? I gather from your former answer that there is?—Yes, there is.

14562. Do you find the presence of these salts of iron add to your difficulties, or are they helpful?—They are helpful rather, but if I had to treat each sewer by itself I should find that they would be very far from helpful, because in the Hockley main we occasionally have an enormous quantity of acids in proportion to the quantity of sewage. The sewage from the Handsworth and Aston sewer, on the other hand, is distinctly alkaline, and the same may be said of the other sewers in a less degree. As all the sewers enter the one outfall which feeds the roughing tanks, the acid sewage is completely neutralised by mixing with the alkaline sewages.

14563. Then there is no one trade effluent which is a serious trouble to you?—No. There have been cases where whole fields have been destroyed with salts of iron in a night, but I have adopted the method of asking all the owners of works discharging acids into sewers to put in intermediate tanks, and to lay from those tanks a very small pipe into the sewers, so that we have a quiet and regular flow—a constant flow, I may say, of acid sewage into the sewers instead of intermittent discharges of considerable volume.

14564. That has largely reduced your difficulties?—That has very largely reduced our difficulties.

14565. You think that is generally advisable to be done?—Yes.

14566. Then with regard to the presence of trade effluents there is no other point you wish especially to call our attention to as being a special difficulty in your way?—No.

14567. (*General Carey.*) In that way the volume is regulated?—Yes.

14568. What further treatment do you subject the effluent from your septic tanks to?—We treat it on the land.

14569. How much land have you available for the purpose?—About 1,800 acres. Altogether our property extends to 2,830 acres at present. We have 33 acres being used for the disposal of sludge, and we have 950 acres being used as intermittent downward filtration beds; 851 acres are used as broad irrigation. We have 764 acres of land which is not being irrigated, and we have in roads, buildings, rivers, tanks, etc., an acreage of 229. I have not given you the odd figures, but altogether it makes up the 2,830 acres.

14570. Is this 764 acres capable of being irrigated?—No; not very well. They are on high ground to start with, and the ground is very far from being suitable. It is very close stiff marl.

14571. (*Colonel Harding.*) Can you tell us what is the effective amount of land which you actually have available for treating your septic effluent now?—1,836 acres it would work out to.

14572. You are actually using that now for the treatment of your septic effluent?—Yes, that is so.

14573. And you are doing that partly by intermittent downward filtration, and partly by broad irrigation?—Exactly.

14574. Explain to us what you mean exactly by broad irrigation in this case?—Land which is cropped or land which is pasture.

14575. Do you flood a certain portion of it and then leave the land free from sewage for a considerable period?—We select certain portions for irrigation, and then leave the land to rest for a day or two, and then flood again, and so on.

14576. But in the case of intermittent filtration you probably do not attempt to raise crops?—We do not attempt to raise crops at all on land reserved for this purpose until it has become sick, then it is cropped for a season.

14577. The land is used as a filter?—That is so.

14578. In a way quite analogous to the contact beds, I suppose?—Precisely.

14579. Is the land at your disposal sufficient for the purpose now and likely to be sufficient for some time to come?—It is not. Our increase of population is so great that we would require to buy and to lay out more than an acre per week to keep pace with the increase.

14580. What is being proposed then to meet the difficulties of the future?—I have already prepared plans of four or five acres of percolating beds.

14581. These works are not yet settled upon?—They have been sanctioned by my Board, but they have not yet been approved by the Local Government Board.

14582. It is still in the form of a project?—Yes.

14583. What depth of material do you propose to use in these beds?—5ft.

14584. What method of distribution?—The method of distribution will be somewhat akin to the method adopted at Salford. I do not propose to follow the Salford method altogether. It will be rather different from anything which, I think, is at present in existence. We have a long conduit leading from here to Curdworth, about five miles in length. At the end of that conduit I propose to put down a series of Dortmund tanks, with the view of arresting the humus in the septic sewage. The supernatant water I propose to lead on to three acres of what I call primary beds, and the filtrate from these three acres I propose to lead on to two acres of practically similar beds at a lower level. By following that method I shall not be obliged to pump water at all; the water will flow from our septic tanks here right down the great conduit, and as that conduit has a gradient of only 2ft. to the mile, while the river has a fall of about 40ft. in five miles, I am gaining by every foot I go down the valley, so that when I come to

the site of the proposed bacteria beds, which I shall show you to-day, I shall have rather more than 30ft. of head between the top water level in the Dortmund tanks and the bottom of the secondary beds.

14585. It is not necessary, I think, that we should pursue this. We are interested to know that you are proposing modifications, but for the present it suffices to know that your object is to prevent more septic effluent going on the land than a certain quantity. Can you give us an idea what that certain quantity is that you find practicable to be dealt with?—I will put it to you in this way: on each acre of land which we have available for the purpose of irrigation, whether by broad irrigation or downward intermittent filtration, we are putting sewage from a population of 460 persons.

14586. What does that come to in gallons?—In gallons that would be about 15,000 gallons an acre.

14587. Then you find it practicable to deal with septic tank effluent on your kind of land to the extent of 15,000 gallons per acre?—I do.

14588. But you think it inadvisable to go beyond that?—I think I am going too far now.

14589. From your experience, how far do you think it is safe to go?—Not more than 300 people to the acre.

14590. That would be 12,000 gallons?—Rather less, 10,000 gallons per acre.

14591. About 12,000 gallons per acre?—Rather less than that.

14592. What is the nature of your land; is it open gravel?—It is very varied. We have all kinds of land really. We have close stiff clay, we have marl, we have gravelly material, we have gravel, we have a very little sand, and I am sorry to say we have a good bit of peat.

Mr. J. D. Watson, A.M.INST., C.E.

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14593. I think the only other question it is necessary to ask you at this stage, Mr. Watson, is what kind of result do you find from septic processes followed by treatment on land?—We obtain purification equal to about 90 per cent.

14594. Are you troubled now, as I think you were when we visited your works before, with the presence of sewage fungus in the drains?—Yes, more or less.

14595. Is the quantity of it very large?—It is not.

14596. Have you any complaints in regard to that?—No, not at all. That fungus, I take it, is absolutely harmless, but for the sake of appearance we eliminate it from the effluent before it is discharged into the rivers.

14597. I think it was suggested to us when we were here before that there was a great deal of detritus from this fungus which passed away with the effluent, and which afterwards putrefied?—I do not know positively what it was at that time, but it is not so now.

14598. Now you get a result which is fairly limpid, is it?—Yes.

14599. And which gives you chemically a purification of 90 per cent. on the original sewage?—90 per cent. on the original sewage.

14600. What amount of purification do you obtain by the septic tank? In other words, how does the septic tank effluent compare with the crude sewage?—There is a table showing that.

Mr. J. D. Watson, A.M.INST., C.E.

20 Oct. 1902.

ANALYSES OF SEWER AFFLUENTS AT SALTLEY.

RESULTS EXPRESSED IN PARTS PER 100,000

Dissolved Solids.	Suspended Solids.	Free and Saline Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrogen as Nitrates and Nitrites.	Oxygen absorbed.		Alkalinity.	Total Nitrogen.		Nature of Sample.
						Unfiltered.	Filtered.		Unfiltered.	Filtered.	
145·5	73·5	4·16	1·56	12·5	0·30	13·43	5·67	18·6	8·07	6·43	Saltley sewage.
134·0	54·6	3·50	1·52	24·5	0·33	17·38	10·26	18·2	8·33	6·55	Rea sewage.
145·1	70·4	3·37	1·67	21·6	0·89	14·04	5·49	0·5	9·34	7·21	Hockley sewage.
94·8	88·4	5·17	1·95	12·1	0·12	13·33	5·50	22·4	9·45	6·79	Aston sewage.
129·1	67·6	3·87	1·66	20·3	0·44	15·32	7·61	—	8·84	6·78	Computed average sewage.

Mr. J. D. *Watson*, A.M.INST., C.E.

20 Oct. 1902.

ANALYSES OF PRINCIPAL FARM EFFLUENTS.

RESULTS EXPRESSED IN PARTS PER 100,000.

Dissolved Solids.	Suspended Solids.	Free and Saline Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrogen as Nitrates and Nitrites.	Oxygen absorbed.		Alkalinity.	Total Nitrogen.		Nature of Sample.
						Unfiltered.	Filtered.		Unfiltered.	Filtered.	
121·2	2·3	1·37	0·17	17·4	0·56	1·33	—	20·4	3·09	—	Castle Bromwich effluent.
84·6	2·9	1·53	0·20	12·3	0·45	1·48	—	15·8	2·68	—	Plant's Brook effluent.
112·9	2·7	2·29	0·20	17·6	0·42	1·91	—	21·9	3·33	—	Water Orton effluent.
100·0	2·7	2·01	0·21	15·9	0·43	1·91	—	16·3	3·31	—	Minworth effluent.
107·8	5·1	2·03	0·21	16·2	0·42	1·99	—	17·0	2·83	—	Curdworth effluent.

ANALYSES OF EFFLUENTS FROM ROUGHING TANKS AND SEPTIC TANKS AFTER CESSATION OF LIME TREATMENT.

RESULTS EXPRESSED IN PARTS PER 100,000.

Dissolved Solids.	Suspended Solids.	Free and Saline Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrogen as Nitrates and Nitrites.	Oxygen absorbed.		Alkalinity.	Total Nitrogen.		Nature of Sample.
						Unfiltered.	Filtered.		Unfiltered.	Filtered.	
125·7	24·6	4·29	1·19	20·0	0·44	11·96	8·17	—	7·13	6·32	Roughing tank unlimed 1901.
115·4	24·5	5·26	1·06	20·3	None.	10·77	6·85	23·7	7·42	6·58	Septic tank unlimed 1901.

Mr. J. D. Wateon, A.M.INST., C.E.

20 Oct. 1902.

14601. Will you be good enough to put this in?

(The table was handed in.)

Can you give us the figures with regard to the albuminoid ammonia and oxygen absorbed?—Yes; our oxygen absorbed varies a good deal, but I am rather surprised to find that, taking the average, it is as low as it appears here. The average is 15·32.

14602. Is that per 100,000?—Per 100,000. My chemist gives me a return every week. Last week it was as high as 30, and in one case rather more, 31·79.

14603. But give us an average?—The average of the whole year is 15·32.

14604. Then give us a similar average for the septic tanks?—The average from the septic tank is 10·77.

14605. That is only a reduction of about 30 per cent?—Yes; just about that.

14606. And what is the final figure in the filtrate as it passes to the stream?—1·33 at Castle Bromwich, 1·48 at Plant's Brook, and the others are about 1·91.

14607. The first two you mention would come just within the provisional standard of the Mersey and Irwell Board?—Yes.

14608. But the last one would not?—The last would not. They are from recently drained land which has not yet been properly seeded with the nitrifying organism.

14609. Had you better results when less quantity was put on to the land?—Oh, very much.

14610. You have constant analyses made of the effluents?—Yes, each week.

14611. You have a resident chemist?—Yes.

14612. What is his name?—O'Shaughnessey.

14613. He is employed entirely on the work?—Entirely on the work.

14614. So that you have regular and careful records?—Every day, every week.

14615. You will be good enough to put those in?—Yes.

(*General Carey.*) What proportion of the septic effluent comes from the filters that have been constructed?

14616. (*Colonel Harding.*) Have you any filters now at work?—Yes, two.

14617. Are they contact filters?—They are continuous percolation beds.

14618. What is the extent?—A quarter of an acre each.

14619. What is the volume that passes through them?—About half a million gallons.

14620. I think what the General wanted to know was what was the total volume?—Half a million a day.

14621. With that exception, everything is going on to the land?—Yes.

14622. (*General Carey.*) This effluent from the filter is going into the stream direct?—Into the stream direct.

14623. (*Secretary.*) Is it a good effluent?—They are only just started.

14624. (*Chairman.*) How long has it been at work?—The nearest one has now been at work about ten hours.

14625. So it is impossible, of course, to gauge?—Yes; the other one has been at work about three weeks perhaps.

14626. Can you give us any idea of the cost at which you obtain the results of your sewage purification, including interest on capital outlay and after crediting the farm account. What is the nett cost of your sewage works to the area in question?—£75,067. That is, for the current year.

14627. And that represents a cost per head of how much?—About 1s. 9d.

14628. What does a 1d. rate produce from that area?—About £15,000.

14629. So that this nett cost represents 5d. in the pound?—Yes.

14630. (*Mr. Stafford.*) Did you say you were going to acquire further land?—Not at present. In the meantime, I have got authority to prepare plans for five acres of percolation beds, which will take the place of additional land. Did I give you earlier in the day the increase of our population?

14631. (*Chairman.*) Yes, you did. Let me ask you with regard to the percolation beds which you have actually at work, what is their diameter?—120ft.

14632. And what systems of distribution have you?—In one case we have a three armed distributor on the Barker's Mill principle. This distributor was made by Adams, of York; and the other is a patent of Mr. Scott Moncrieff, made by Manlove, Alliott and Co., of Nottingham. It is a trough arm carried round on a stationary circular rail, and actuated by means of an oil engine.

14633. (*Mr. Stafford.*) The original cost was £800, you say?—The cost of it, including the rail, was upwards of £800.

14634. (*General Carey.*) Did you pay for the patent?—No.

14635. (*Chairman.*) How many people are employed altogether in connection with the sewage works?—Generally between 300 and 400. In the busy seasons that number will be increased by 100 people more.

The Commissioners proceeded to view the sewage works.

FIFTIETH DAY.

Tuesday, 21st October, 1902.

SHEFFIELD.

PRESENT:

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P. (*Chairman*)

Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Colonel T. W. HARDING, J.P.
Dr. JAMES BURN RUSSELL.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary.*

ALSO PRESENT—

Dr. A. C. HOUSTON.
Mr. COLIN C. FRYE.

MINUTES OF EVIDENCE TAKEN AT THE SHEFFIELD SEWAGE WORKS.

Mr. C. F. Wike.

21 Oct. 1902.

Mr. CHARLES F. WIKE, City Surveyor, and Engineer of the Sheffield Sewage Works, called; and Examined.

(*Chairman.*) Will you state very briefly what is being done at the Sheffield Sewage Works?

(*Witness.*) I have here a report, which was made to the Highway Committee in connection with the disposal of the sewage, which I will send to the Commission. It contains a brief history of these works. The land in use comprises about 23 acres. The works were started in 1886, and the lime process was adopted, 30 tanks being used.

14636. In 1866?—In 1886.

14637. You began with precipitation of lime?—With precipitation by lime, and we continued the use of the

system exclusively until about four years ago. We had a large accumulation of sludge.

14638. Was that dealing with the whole of your sewage?—Not at first.

14639. What proportion did you begin with?—Of sewage?

14640. In 1886?—The whole of the sewage came to the works.

14641. In 1886?—In 1886 it was treated for about ten or twelve hours a day. That was before I came. I am giving the Commission what was handed down to me. The works then were in charge of Mr. Alsing, the engineer who designed them, who also designed the Bradford Works and the works for one of the divisions of Glasgow; I think it was the Govan division.

14642. (*Dr. Russell.*) Dalmarnock?—Yes, that was it. Then Mr. Alsing had the management of the works. Afterwards he resigned, and the committee under which he officiated was amalgamated with the Highway Committee, who then took over the management of the works. Since that date we have treated all the sewage. There is, as usual in such works, a storm overflow, but unless the circumstances are exceptional all the sewage passes through the tanks.

14643. (*Chairman.*) The precipitation tanks?—The precipitation tanks, and there is very seldom any overflow. There are times when it is unavoidable, but these are very rare.

14644. What date was that?—That was about nine or ten years ago; I can give the shorthand writer the date.

14645. Roughly?—Yes. We still went on with the same system, and then about ten years ago we began to clear the sludge away. We have already removed about 450,000 tons of sludge.

14646. What was your method of disposing of the sludge?—Until this time there was no method. It was simply left, except the small quantity that the farmers fetched; which was infinitesimal compared with the quantity that was made.

14647. It was left on the ground?—Left on the site.

14648. Piled up from the tanks?—Piled up from the tanks—piled up in the reservoirs, and allowed to consolidate and settle there.

14649. It was the accumulation of sludge that made you determine to try some new method?—Not exactly that, sir. We wanted to get rid of the sludge. We had no room to put it here, and the committee decided to acquire some land five or six miles away on lease, and we arranged with the railway company to carry the sludge down to this land at 6d. per ton. There were about 11 acres. Since then another 11 acres have been acquired, so that we have now about 23 acres of land. We entered into an agreement in respect of the land first acquired, to strip the turf off, put the sludge on, and returf it. The land is, to a certain extent, underdrained as well, but not very extensively. We send 20 to 30 wagon loads of this stuff a day. Having so cleared part of the site, we were able to put down these bacteria beds, which we had not room to do before. Then we put down beds with an area of about three acres, including tanks.

14650. That was four years ago?—I will give you the exact dates.

14651. Roughly, about four or five years ago? The committee went to Sutton and several other places, to see what was going on there, and afterwards decided to lay out all the land we could spare as bacteria beds, as an instalment of a large experiment. The land we wanted for the coarse beds had a greater area than the land for the fine beds. The coarse beds were filled with large gas coke, and the other beds with fine breeze; we find out now that it was too fine for the purpose. At first we could pass half a million gallons a day through each of these three coarse beds.

14652. Half a million gallons a day?—Yes; but we could not pass that quantity through the fine ones. The fine ones will only take about 250,000 gallons each per day; and this process has been going on about four years.

14653. Do you pass on to the coarse beds the crude sewage untouched?—No; the sewage has to pass through the settling tanks.

14654. What size are they, about roughly? Large?—No, small, about 37ft. by 11ft. tanks.

14655. (*Colonel Harding.*) Mere grit tanks?—Mere grit tanks, detritus tanks to take the road detritus and the offal from the butchers, etc.

14656. (*Chairman.*) There is no treatment of the sewage before it goes to the coarse beds?—It has all to go through these tanks, and has then to be pumped. The land where these coarse beds are, is at a higher level than the old works; therefore we have to pump the sewage back. In passing through these tanks it loses a certain amount of grit by settlement, and then it is put on to the surface of the coarse beds. One of these coarse beds now, after four years, will not take any more.

14657. (*General Carey.*) What is the depth of these coarse beds?—About 5ft., and the fine beds about 3ft. 1in. or 2in. I have all the details.

14658. (*Chairman.*) One coarse bed is quite choked up, and the others are damaged in capacity?—The others are damaged in capacity.

14659. You have measured the diminution?—Yes, they have diminished about 50 yer cent.

14660. Both of them?—One more than the other. One is 53 per cent., the other is about 60 per cent. I can give you all these in detail afterwards.

14661. We only want a brief outline at present?—I cannot keep them all in memory, but I have them here for the Commission.

14662. (*General Carey.*) You work the beds in cycles?—Yes.

14663. (*Chairman.*) You are not working the two now. You left off working the first one because it got choked up?—I have left it for some time. I thought it would be interesting for the Committee to see it.

14664. What are you proposing to do now?—We are buying this area of land that I have pointed out to you.

14665. You have bought 60 odd acres?—We have bought 60 odd acres, and we are arranging for more.

14666. Amounting to over 100 acres altogether?—About 105, I think. We have served notices now on the other owners to take the remainder of the land.

14667. What are you proposing to do with the land?—We are proposing to proceed on somewhat similar lines to those we have already been going on, but we are anxious to hear what the result of the Commission is.

14668. How are you proposing with this land to treat your crude sewage, beginning with the crude sewage?—We are proposing to have sedimentation tanks, and to put it through ordinary contact beds.

14669. And then on to the land?—We have not much land left.

14670. I see your land is for your new beds?—That is so. I have here a scheme, which I can show the Commissioners, and this will give them a general idea of what has been proposed. Prior to the preparation of this scheme investigations were made as to the feasibility of taking the sewage either direct to the sea, or further down the valley, and there treating it on land. Mr. Rienzi Walton was sent down by the Local Government Board. It had been suggested to them that there were areas where the sewage of Sheffield could be dealt with; one was a place called Thorn Waste. Mr. Walton and myself went down there about two years ago, but we found the idea was quite impracticable, because it would mean the destruction of an industry. There is an extensive trade in peat moss litter, and quite a colony of labourers is employed. The soil was not suitable, and the land was very dear, and that was given up. Another difficulty is that of levels. Although some parts of Sheffield are about 600 feet above Ordnance datum, these works are only 100 feet above. The city is a large one, its length is about 12 miles. The nearest point on the coast is about 60 miles away; therefore, if you took a straight line from Sheffield to the sea, you would only get a gradient of 16in. per mile. Obstacles like rivers and hills have, however, to be crossed, so pumping would be necessary, and it was found that four pumping stations would be required. The idea of a culvert to the sea had also to be given up, and the only thing left for us now is to do the best we can with the land here. If you get much further down you get into Rotherham.

14671. So far you have been treating at the rate of 750,000 gallons a day your crude sewage simply with grit tanks, and then coarse filter and fine filter beds?—Yes.

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14672. Of the coarse filter beds, one is wholly clogged up, and the others are rapidly clogging up, and you have now purchased a quantity of land, not to treat your sewage with the ordinary land treatment, but to erect on that land bacterial contact beds together with sedimentation tanks?—Yes, that is what we have in mind.

14673. Is there anything else we ought to know before we go round?

14674. (*Colonel Harding.*) It would be interesting to know to what extent they are proposing to allow the sewage to settle. Are you proposing to settle at such a slow speed as really to make your settling tanks into septic tanks, or not?—We have scarcely got as far as that yet.

14675. (*Chairman.*) What is the population you would have to deal with?—The population of the city itself is about 400,000.

14676. The population of your sewage area?—Sheffield at present is not what is called a water-closet town, but we are rapidly converting. We are taking over districts outside the city.

14677. What is the normal flow?—The average of the sewage that comes through the works is about seventeen and one-third million gallons per day.

14678. What proportion of that is trade refuse—have you any idea?—That is rather a difficult question to answer definitely. In Sheffield many of the older sewers have been brooks or watercourses—that obtains a great deal in the North of England—and they have been converted into sewers. They take large quantities of surface water, and water from different works—we know we get a good deal too much of that. We find that some of the large works here use a great quantity of water from the river for condensing and boiler purposes. Instead of putting it back into the river, the water is put into the sewers, and we think that, roughly, there is about, say, 3,000,000 gallons of water going to the sewage works that ought to go into the river; it is quite pure enough.

14679. 3,000,000 gallons of pure dilution, you think, really?—I think so.

14680. What proportion, roughly, is trade refuse?—The chemist estimates that we get about 100,000 gallons of trade refuse, iron pickle, that goes into the works.

14681. That is the chief trade refuse here, I suppose?—The chief trade refuse, yes. There are large breweries; they put a certain quantity of trade refuse in, but it is not noticeable enough to trace. There is a tannery which has been started recently, and we can trace the refuse in the sewage that comes to the works.

14682. What do they send in about daily, do you think, roughly—a large quantity, or only a small quantity?—Not a very large quantity. They have only been at work about six or nine months.

14683. It is the pickle that is the chief trade refuse?—Yes.

14684. And that, you say, is 100,000 gallons in your 17,000,000 gallons?—Yes.

14685. Not a larger proportion than that?—Well, there is this large flow from the works that I have mentioned—from two and a-half to three millions. That, however, is not what you would call trade refuse, I suppose.

14686. A great deal of that, of course, results from the manufacture of armour plates, and, of course, it is scarcely contaminating. The only possible contamination is just the iron?—The chemist will explain it. The other day we got a lot of whale oil coming down.

(*Councillor Carr.*) That comes from the hardening process of the files and small saws, but, generally speaking, Sheffield has not much trade effluent that is of a detrimental character.

14687. (*Chairman.*) A great deal of your trade refuse is largely diluted with water?—Yes.

(*Councillor Uttley.*) The refuse from the paper works is the matter that would be likely to principally interfere with the sewage.

(*Witness.*) The paper works are outside the city.

14688. (*Chairman.*) They do not discharge into your stream?—Not into our sewers.

(*Colonel Harding.*) It might be well, sir, to get the typical analysis of the crude sewage and the results obtained from filtration from Mr. Haworth, the chemist.

14689. (*Chairman.*) We can have that, I suppose?—Yes; I have got diagrams and very full particulars of analyses that have been taken by the chemist over these last three years.

14690. This estimate of 100,000 gallons of trade waste is only a rough calculation?—A rough calculation of the chemist.

14691. That is to say, undiluted trade waste?—Yes; we think it comes from the wire-drawing plant. It comes in, and we can tell at once that it is here.

14692. Is that sent in regularly or very irregularly?—It is sent in at fairly regular intervals, but instead of distributing it as they should do, they simply open the tank and send it in all at once.

14693. (*Colonel Harding.*) So that it is sent irregularly?—It is sent in all at once.

(*Councillor Carr.*) As far as periods of time go, it is regular; as regards quantity, it is irregular.

14694. (*Chairman.*) Is it distributed or in bulk?—It generally comes all at once.

14695. (*Colonel Harding.*) Does it cause any inconvenience to your treatment?—Not to the lime treatment.

14696. Does it to your bacterial process?—A little.

14697. You would not feel it at all if it were distributed over the 24 hours?—I think not, in the big volume of sewage that we have.

14698. (*Dr. Russell.*) Have you a large extent of macadam road?—A very large extent. We have 387 miles of roads altogether, and the macadam roads are something over 250 miles.

(*Councillor Uttley.*) The one difficulty we have is in localising this matter. We have got about 200 miles of macadam road. That is in the old city; about 250 miles altogether now.

14699. (*Chairman.*) In your old system with precipitation you brought your sewage into tanks; you added your lime, you allowed it to settle, and then you discharged the clear effluent into the river straight?—It passes through aerating weirs, and then the effluent goes straight into the river.

14700. With no other treatment beyond the precipitation?—No.

(*Councillor Carr.*) Both systems are in operation, of course.

14701. (*Chairman.*) What result did you get from that—50 per cent. of purification.

(*Councillor Carr.*) We obtain a very much clarified effluent, very bright. I thought, perhaps, the Commissioners would have gathered that we were treating the whole of the sewage from the answer made. The 750,000 gallons is the bacteria beds. I want you to understand that the whole of the sewage is treated.

14702. (*Colonel Harding.*) By the first process?—Either by lime or bacteria.

(*Chairman.*) To the extent of 750,000 by contact beds and the rest by precipitation?

(*Councillor Carr.*) Yes; I thought the Commissioners would like to understand that.

14703. (*Chairman.*) We know exactly from the analysis that the amount of purification from the precipitation process is, roughly, 50 per cent.?—Yes.

14703.* Has your effluent been complained of?—(*Councillor Carr.*) I do not think the effluent has been complained of, but the action of the effluent after it has gone into the body of the stream.

(*Colonel Harding.*) The action takes place after it has left your works?

(*Councillor Carr.*) Yes.

(*Chairman.*) After the lime process the other effluent is very much better. Does the other effluent satisfy the Rivers Board?

(*Councillor Carr.*) Yes.

(*Colonel Harding.*) It has generally been reported on as very good?

(*Witness.*) We get up to 97 per cent. of purification.

(*Councillor Carr.*) Dr. Wilson expressed himself satisfied with our effluent from the bacteria beds.

(*Witness.*) We have also constructed a big sedimentation tank which will hold about 400,000 gallons, and two

coarse filters, two first contact beds to take the effluent from that, and they will do about three-quarters of a million gallons a day. They have only been at work a month or two months, therefore I cannot give the Commission any statistics.

14704. (*Chairman.*) When you inspected these contact beds you were convinced from your examination of works elsewhere that you could treat the crude sewage with your contact beds with nothing beyond mere grit tanks?—Yes.

14705. You have been surprised to find they have silted up to the extent they have?—I expected they would silt up, but I think with respect to the coarse beds we have been describing, that if we had had bigger catch pits they would not have silted up so quickly, and if we had a less mileage of macadamised roads we should have a much better result, as an immense quantity of grit is washed down. Many of our roads are very steep indeed, and we get a great deal of scour and a great deal of grit. Under the road you have just passed over there is a sewer with a gradient of about two yards in a mile, and sometimes we get about 2ft. of grit in it.

14706. Your opinion is the choking of the bed has arisen from the grit and not from the products of bacterial action?—In a great measure.

14707. Your examination of your beds has confirmed you in that view?—Yes; I think so.

14708. (*Dr. Russell.*) What amount of deposit do you get from the detritus tanks in the year?—The catch pits?

14709. Yes?—We get about 50 to 60 tons a week.

14710. (*Chairman.*) We shall know exactly what is the constitution of your crude sewage, but is it a strong sewage or a weak sewage?—It is a medium.

14711. I mean it contains a great deal of excreta?—Yes. Sheffield is not a water closet town, but it is being rapidly converted.

14712. I mean the proportion of excreta discharged into your sewage has been continually increasing since you have been at work?—Yes.

14713. And now it is of such an extent as to make your sewage, as you say, a medium sewage?—Yes.

14714. And it is not mere slop water?—Oh, no.

14715. (*Dr. Russell.*) What do you do with this detritus?—It is simply taken out and deposited with the sludge five or six miles away.

14716. Then I understand that in some of the sewers there is a deposit, because there is not a sufficient gradient?—Yes; this special one here approaching the works.

14717. The road we drove along is in a very bad condition?—It is a private road. It has only been inside the city a short time.

14718. (*Colonel Harding.*) I think we only want a typical analysis of the crude sewage and the results obtained from Mr. Haworth, but may I ask Mr. Wike one question. Is the Commission to understand that the Corporation of Sheffield has not yet formulated a scheme, although they have a material part of the land in their possession?—They have formulated a scheme.

14719. What is the scheme?—Practically as I have described it.

14720. How far is it formulated?—Well, I have got plans out showing the development of the whole of this land.

14721. Laid out as bacteria beds?—Yes.

14722. So that the Corporation appreciate that to make their bacteria beds successful they will have to increase the area of the settlement?—Yes.

14723. There is not really a definite scheme which has been approved by the Committee or the Corporation?—Well, it has been approved in principle by the Committee.

14724. (*Chairman.*) You have said that you did not consider the settling tanks you are about to make septic tanks. Does one gather from that you think that all that is necessary is to remove more effectually the grit than you have done? Is that simply your purpose in extending your work?—Yes, so far as the present extension of the settling tanks is concerned.

14725. By saying you did not consider them as septic tanks you mean you do not think it necessary to await any change in the sewage before it goes on to the contact beds?—No.

(*Councillor Carr.*) In further answer to Colonel Harding, so far as the principle is concerned, I think our experience of the bacteria beds is sufficient to warrant us in going on and laying out a complete system, to the best of our knowledge, on the land adjoining.

(*Colonel Harding.*) Is it proposed to do that?

(*Councillor Carr.*) That is our mind at the present time to the extent that Mr. Wike has gone the length of making plans for it, with a view to submitting them to the Committee for consideration.

14726. You are quite satisfied from your experiments that if you enlarge the settlement area so as to get rid of the grit and the grosser solids, you can manage the remainder on the beds?—(*Witness.*) Yes.

14727. Are you meanwhile experimenting on a small scale?—We are.

14728. Can you indicate to us quite briefly the nature of that experiment? What volume are you dealing with experimentally in this other way?—We are dealing with 2,400 gallons per filling on clinker beds treating septic tank effluents.

14729. Quite a small experiment?—Yes.

14730. How long has it been carried on?—It has been carried on from three to four years.

14731. Are you satisfied with the result obtained there?—With the results obtained there, yes.

14732. (*Chairman.*) How are you treating that exactly, Mr. Wike?—We have got two of these brick tanks, which we can gauge very accurately, and in one case we have adopted the mode of sending the sewage into a septic tank, and in the other into a sedimentation tank.

14733. How do you distinguish between the two? Is one covered and the other not covered? Is that all you mean?—Well, it is covered with its own scum; that is all.

14734. The open one is?—Both are open.

14735. (*Colonel Harding.*) This is rather material, Sir Michael, the rate of flow into the tanks, the one you call sedimentation and the other septic?—I can read it to you. I have got it down here. The one is a catch pit with a capacity of 50,000 gallons and a depth of 5½ft. The other tank is adapted for 50,000 gallons, with a continuous flow of sewage. It enters at a point 2ft. 6in. below the surface; that is to say, we have put a plank and made a trap.

14736. Are we not misunderstanding each other? Did not I understand that you were dealing with 2,000 gallons a day experimentally, but here is a settlement tank with a capacity of 50,000 gallons?—Yes, which takes half, because we have two tanks, one the septic tank and the other the open tank you are speaking about. Both the tank you refer to as the open tank and what we call the septic tank are open. Each of these tanks will contain 50,000 gallons.

14737. And the 2,000 gallons is going into these tanks with a capacity of 100,000 gallons altogether. You have two tanks of a capacity of 50,000 gallons each to receive the 2,000 gallons per day. Is that it? Does that mean that you have 25 days' capacity, and that the sewage remains 25 days?—No.

14738. There is some misunderstanding?—If the Commission will allow me I would rather read it.

14739. Shall we get that from Mr. Haworth?—Yes; he has had the management of this. I think probably the Committee would have it explained better on the spot; I think you will see it a great deal better.

14740. We must get it from Mr. Haworth. The experiment appears to me to be interesting, because that is what is guiding the Corporation of Sheffield. They have found that as the result of putting absolutely crude sewage upon the beds the beds are absolutely sludged up, and they are trying a small experiment with natural sedimentation, and also with sedimentation carried sufficiently far to bring about septic action, and I understand from the engineer that they are obtaining reliable results, which are apparently guiding them in their scheme?—I think if you would allow me to read this, that point would come out that you have raised.

14741. (*Chairman.*) How long will it take?—Five minutes.

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(*Councillor Carr.*) Unless you like to have it *viva voce* from Mr. Haworth.

(*Colonel Harding.*) I think it will be shorter. We do not want too much detail.

14742. (*General Carey.*) Are you not under limit of time by Act of Parliament or the Local Government Board?—We are not.

(*Councillor Carr.*) We are under pressure by the Yorkshire Rivers Board, but we have our own views upon the matter, and we want to deal with it as speedily as we can, but because we have to spend this money we do not want it to lie idle. We want to put our house in order, and we mean to do so. If the Commission can give us advice with respect to that we shall be glad to have that advice. We do not want to spend the money and find we are wrong, but as far as the present is concerned we think we are on the right lines.

(*Chairman.*) I think we might now visit the works.

(*The Commissioners proceeded to visit the sewage works.*)

Mr. J. Haworth.

Mr. JOHN HAWORTH, Chemist of the Sheffield Sewage Works, called; and Examined.

14743. (*Chairman.*) Are you a Fellow of the Chemical Society?—I am.

14744. Any other title?—No, sir.

14745. You are the chemist of the sewage works?—Yes.

14746. You have been superintending the experimental plant?—Yes.

14747. Which now has been in full action for more than 12 months?—Yes, some portions have been at work for more than two years.

14748. Which portion has been at work for two years?—The septic tank has been acting since June, 1900.

14749. And the settling tank has been acting?—I can give you the exact date, sir.

14750. We only want it roughly, I think?—About 12 months since August, 1901.

14751. The same sewage is sent into the settling tank, and into the septic tank?—Yes; we simply divide the channel.

14752. Can you give us any analyses of the crude sewage which is thus treated?—Yes.

14753. Do you meet with great variations, or is there tolerable regularity?—There are great variations at times, produced by trade waste chiefly. I have the analyses. Some portion of the analyses are plotted on the diagrams, which I think you have seen.

14754. Can you make a general statement as to the average absorption of the crude sewage?—The crude sewage absorbs about 5 grains per gallon of oxygen and yields an average of about ·5 of albuminoid ammonia.

14755. What is the amount of suspended solids in it?—The amount of the suspended solids is 33 grains per gallon on the average.

14756. And of the organic?—There is a typically high one here, 35·04 grains of mineral solids per gallon, 18·86 of volatile and organic, and 55·9 of total solids. That is a high amount.

14757. What change does the trade refuse bring about in your crude sewage?—The iron pickle, of course, increases oxygen absorption very considerably. When we get it in combination with tannin we get ink produced practically, which, of course, is very difficult to treat.

14758. It comes down to your outfall as ink?—It comes down as ink—yes; and, of course, the lime process has very little effect upon that; it simply has to come out black. Of course, that does not occur very frequently, perhaps once now and again, and means have been taken to avoid that.

14759. (*Colonel Harding.*) Means are being taken?—Yes.

14760. (*Mr. Wike.*) With respect to the tannery?—Yes.

14761. You are calling upon the tannery and the pickle people to store?—Only the tannery. The pickle people we are investigating.

14762. (*Colonel Harding.*) In many large towns it is made a condition of admission to the sewers that equal flows shall be discharged during the 24 hours, and in that case probably, Mr. Haworth, they would not trouble you at all, would they?—Not if spread over the whole 24 hours.

(*Mr. Wike.*) With respect to the tannery they have arranged to put tanks down?

14763. (*Chairman.*) So that the flow may be uniform?—Yes.

14764. About the pickle, you have not taken any steps at present?—No.

14765. Each of these tanks holds 50,000 gallons, I think?—That is so.

14766. The settling tank you run how much in?—Into the settling tank we run three fillings per day, but we could put more in if it was necessary.

14767. You allow it to settle?—For three hours.

14768. And then it goes on to your first contact beds?—It goes on to the first contact bed.

14769. What is the analysis of the effluent from the first contact bed?—The average for one month is 1·16 grains per gallon oxygen absorbed in four hours. That is produced from a tank effluent absorbing 2·74 grains per gallon.

14770-1. Perhaps I ought to have asked you first what is the constitution of the effluent from the settling tank itself. How much suspended matter. (*Colonel Harding.*) The ·04 grains given us was the average?—The maximum we have had has been 14 grains per gallon and the minimum 1·15. The average is from 3 to 4 grains. I have not got it totalled up here, because I am continuing the series.

14772. (*Chairman.*) What are the other features of the effluents that you can give us?—Frequently they are non-putrescible, but not uniformly so.

14773. Non-putrescible or non-putrescent?—Non-putrescible in the incubator. There is a diagram showing the results of that system, and you will see that the first contact effluent frequently comes below.

14774. Are there any other features with regard to the effluent from the settling tank?

14775. (*Colonel Harding.*) There is a point I should like to put. Have you experimented also in the direction of continuous settlement? You have told us you have tried quiescent settlement at the rate of 150,000 gallons a day in the tank?—Yes.

14776. Have you tried that volume passing in the 24 hours continuously?—No, we have not done that.

14777. You cannot tell us the relative merits of quiescent and continuous settlement?—No.

14778. It might be useful, might it not, from your view to try?—Yes.

14779. (*Chairman.*) You have no other features that you can tell us about the effluent from the settling tank?—Not in respect of the effluent from the settling tank.

14780. Then the effluent from the first contact bed contains suspended matter?—Contains suspended matter to the extent usually of from 1 to 1·5 grains per gallon.

14781. That is the average?—That is the average.

14782. The oxygen absorbed?—The oxygen absorbed varies from ·7 to 2·3.

14783. Albuminoid ammonia?—Albuminoid ammonia varies from ·05 to ·22.

14784. Are there nitrates present?—We get nitrates occasionally, about ·09 grains of nitrogen per gallon. The maximum we had has been ·51 grains of nitrogen per gallon, but that is exceptional, and I think that was after we had had a considerable flow of storm water.

14785. (*General Carey.*) How are the beds worked?—We fill them three times a day. It takes about an hour to charge them. We have held them up full for one hour; for a short period we held them up two hours with a very slightly improved effect, and it takes about an hour to discharge, and the remainder of the eight hours the beds remain resting empty.

14786. Have you been able to trace any injurious influence from your trade refuse on the action of the beds?—No; we have not found the trade refuse injurious. We can purify the sewage from the tannery works as it comes

into the works by double contact. There is a trace of colour sometimes after the first contact, but never after the second.

14787. In cases where you get an excess of pickle, can you trace any bad influence on the bed from that?—Not apart from the deposit of the iron oxide in the bed.

14788. That first contact bed has been working now for more than 12 months?—For more than 12 months.

14789. What has been the diminution of its capacity?—We have that bed divided into two portions, a graded portion and an ungraded portion. We gauge the portions separately. We have also got the total capacity. The fifth filling in August, 1891, was 16,070 gallons. The graded portion of that took 7,279 gallons, and the ungraded portion 8,791. On September 19th this year the total is 9,642 gallons, the graded portion 3,403, the ungraded portion 6,239, and that is the 940th filling. The total loss, taking the fifth filling as the start, is 40 per cent. on the total, 53·2 per cent. on the graded portion and 29 per cent. on the ungraded portion.

14790. (*Colonel Harding.*) The only point I want to get at is whether from your experience you are able to judge that you have reached a point beyond which you do not further lose?—I am going on to that point, sir, if I may. The loss during the last six months from March 27th to September 19th, on the whole is only 8·9, of which on the graded portion we have lost 18·1 per cent, and on the ungraded portion 2·3 per cent.; so that the graded portion has been screening off the bulk of the suspended solids that have gone on to the beds. A diagram representing that is shown.

14791. Are you able to form a general conclusion, therefore, as to the permanence of these beds dealing with effluent from these settling tanks, or has your experience not been long enough?—I think one would hardly like to express a definite opinion upon that point.

(*Colonel Harding.*) Then do not do so.

14792-3. (*Chairman.*) Then you have a very small experimental second contact?—Yes.

14794. The dimension of that is——?—The dimension of that is 4 cubic yards.

14795. It is filled with——?—It is filled with clinker.

14796. What size?—The lower portion is 1½in. down to ¾in. There is about 2ft. of that.

14797. (*Councillor Carr.*) Is that supplied by the Health Committee?—That is boiler furnace slag.

(*Mr. Wike.*) It is convenient for us to get that clinker, as there are many large works close by.

14798. (*Chairman.*) Are you making use of that regularly?—Yes; that is filled three times a day. The upper portion of it, I may say, is from ¾in. to ¼in. material.

14799. What are the characters of the effluent from that?—Well, they absorb on the average ·6 of oxygen in four hours.

14800. Albuminoid ammonia?—The albuminoid ammonia is from ·04 to ·07 grain per gallon.

14801. (*Colonel Harding.*) Both are well within——?—The provisional standard of the Irwell and Mersey Board. I have incubated these separately, and I have never had a putrescent sample after the first six weeks of working.

14802. Have they been examined bacteriologically at all?—No, sir, not at all.

14803. Have you determined the nitrates?—The nitrates have varied after the bed had got into working order from ·29 to 1·2 grains of nitrogen per gallon.

14804. (*General Carey.*) Do you put the whole of the storm water on the beds?—Not the whole of the storm water.

(*Colonel Harding.*) That is perhaps a question Mr. Wike would like to answer. How do you propose in any new scheme that you are going to adopt to deal with storm waters?—(*Mr. Wike.*) We are proposing to put it on that piece I have described as the island.

14805. You will have a special area for dealing with storm waters. You would not increase the flow on to the beds that are used for sewage consumption?—No.

(*Colonel Harding.*) I do not think we need trouble Mr. Wike to go further into that.

14806-7. (*Chairman.*) It is proposed to use the island for storm water as a special area, so that the storm water will not come at all on to your bacteria beds?—That is what we have in mind at the present time.

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14808. Then with regard to your septic tank, Mr. Haworth, which also holds 50,000 gallons; you run into that how much in the 24 hours?—57,000 gallons at the present moment. At first we ran in 92,000 gallons, but we found the suspended solids were very considerable, and we reduced it after about three months' working to 57,000 gallons per day.

14809. I should have asked how long has that septic tank been at work?—The septic tank was first filled on June 22nd, 1900.

14810. *Councillor Carr.*) Two years ago?—More than two years.

14811. (*Chairman.*) Have you found it necessary to remove the sludge?—Yes; we have removed the sludge.

14812. How often?—Once.

14813. When was that?—That was on November 11th, 1901.

14814. How much did you remove? What was the volume of sludge?—We removed 116 tons 4 cwt.

14815. (*Colonel Harding.*) What was that, 90 per cent. sludge?—That was sludge containing 77·9 of dry solids. It was after we had dried it. We took it out and dried it in lagoons, and then weighed it.

14816. (*Chairman.*) That was about a year ago?—About a year ago.

14817. (*Colonel Harding.*) Did you make any calculation as to any consumption of sludge that had taken place?—Yes, we estimated the consumption of sludge at a maximum of 31·9 per cent.

14818. (*Chairman.*) What are the characters of the effluent from your septic tank? There is a continuous flow through your septic tank?—There is a continuous flow, yes. We get about 11 grains of solids per gallon in the effluent. It frequently has a strong odour, and is generally black. The blackness is due generally to iron sulphide.

14819. (*Colonel Harding.*) Then in comparing the results of your settlement at an eight hours' rate and your septic treatment at the 24 hours' rate, the differences appear to be these, that in the case of the septic you have some smell and possibility of nuisance?—That is so.

14820. That you have, on the other hand, an advantage from the less sludge?—That is so.

14821. But that with the settling tank, while you have more sludge, you would have a much smaller initial cost in laying down the works, because you would want only one-third of the area?—That is so.

14822. Does that express it pretty nearly?—That expresses pretty nearly our ideas.

(*Councillor Carr.*) That would be dealing with the sludge, of course?

14823. (*Chairman.*) The effluent from your septic tank goes through a coarse bed and a fine bed?—Yes.

14824. What is the result of the coarse bed? What is the feature of the effluent from the coarse bed?—The coarse bed effluent contains generally about 3 to 4 grains of solids per gallon.

14825. Of suspended solids?—Of suspended solids, yes. The average tank effluent absorbs 3·31 grains of oxygen per gallon.

14826. The tank effluent?—The septic tank effluent.

14827. But the effluent from the first contact bed?—From the first contact bed 1·24 grains per gallon.

14828. The albuminoid ammonia?—The albuminoid ammonia from the first contact is ·14 grains per gallon

14829. (*Colonel Harding.*) Are the figures you are giving us the average results of a considerable number of analyses?—This is an average of about 20 analyses; but I have analyses spread over the whole period.

14830. You have given us really a fair average?—A fair average.

14831. (*Chairman.*) Then the fine contact bed is composed of ballast?—We have a bed composed of ballast. The first is composed of ballast, the second of clinker.

14832. Of equal age?—Of equal age. Put down at the same time, filled with the same sewage all through.

Mr. J. Haworth.

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14833. Have you effluents from each of them?—Yes; we have not analysed the effluents from the ballast beds systematically lately because the ballast itself broke down and crumbled.

14834. The effluent became bad?—No.

14835. What were the features of the effluent from the fine clinker?—With the fine clinker the oxygen absorption on the average is about ·65, and the albuminoid ammonia ·06; occasionally it gets above.

14836. Then the average is not very different from the other?—No; if anything, the other has the advantage.

14837. But there is no very large difference?—There is no very striking difference. The nitrate average is about ·49 grain of nitrogen as nitrates and nitrites.

14838. None of these have been examined bacteriologically?—No, sir.

14839. (*Dr. Russell.*) You made an examination of the material in the silted up beds?—Yes.

14840. What was the result?—I have just completed that. The organic and volatile matter amounts to 44·3 per cent., and the mineral matter to 55·6 per cent.

14841. (*Chairman.*) So that the silting up was very largely due to organic matter?—44 per cent. organic and volatile, 55 mineral.

14842. What are the other beds we are to see?—The fine breeze beds.

14843. (*Colonel Harding.*) It would be rather interesting, Mr. Haworth, if you would try to find out the difference between the quiescent and continuous settlement at the same rate per 24 hours. It would be very easy; it might also be useful?—Yes, it would be an interesting point.

14844. (*General Carey.*) You say you did not get better results from the contact beds by longer periods?—No; there was only a slight improvement.

14845. Have you made the experiment of two or more hours?—Not more than two hours. We have never held them up for more than two hours.

14846. (*Colonel Harding.*) You have a weak sewage: but probably with the development of the water close system you will find it stronger?—Yes. I know Mr. Wike is taking away the fresh water.

(*Mr. Wike.*) If not we shall have to increase the capacity of the sewers, because after heavy rains the sewers are very much overcharged.

(*Councillor Carr.*) Some of the roads you have driven over this morning are a foot deep in water sometimes.

(*The visit of the Commission to the Sheffield Sewage Works concluded.*)

LEEDS.

Tuesday, 21st October, 1902.

PRESENT:

Sir MICHAEL FOSTER, K.C.B., F.R.S. (*Chairman*).

Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Colonel T. W. HARDING, J.P.
Dr. JAMES BURN RUSSELL.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary.*

ALSO PRESENT—

Dr. A. C. HOUSTON. | Mr. COLIN C. FRYE.

(Minutes of Evidence taken at the Hotel Métropole, after the visit of the Commissioners to the Leeds Sewage Works at Knostrop.)

Mr. THOMAS HEWSON, M.I.C.E., City Engineer of Leeds, called; and Examined.

Mr. T. Hewson, M.I.C.E.

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14847. (*Chairman.*) I do not remember your titles?—I am a member of the Institute of Civil Engineers.

14848. You are City Engineer of the city of Leeds?—I am.

14849. What is the population of the city according to the last Census?—435,000, I think, now.

14850. What is the amount of sewage the city has to deal with?—The dry weather flow of sewage is now about 16,000,000.

14851. Is that the sewage of the city, or of the adjoining hamlets?—Of the city, minus——. It has just occurred to me that we have an outlying farm where we are now taking a quarter of a million gallons; with that exception, it is sewage of the city.

14852. And of the whole city?—Of the whole city.

14853. There is a considerable quantity of trade refuse discharged into your sewers?—Very large.

14854. Do you take all the trade refuse of the city?—We refuse none. We have not got all.

14855. You have not got all?—We have not got all, but we refuse none.

14856. What is done with the trade refuse that does not pass into your sewers?—It is discharged into the natural watercourses of the city, in some cases, and I should think in most cases now, roughly clarified.

14857. Does that which is received into your sewers form anything like an appreciable portion of the trade refuse of the whole city?—I am not competent to answer that question.

14858. Do you make any special conditions as to the trade refuse, or do you take it without any conditions?—We have conditions—printed conditions.

14859. Can you state very briefly what those conditions are?—They are mainly the roughly screening the sewage at one end, and at the other equilibrating the discharge; that is, the equalising the discharge.

14860. So that it shall be uniform during the 24 hours?—That is so; yes.

14861. Do you insist upon settling tanks in any cases, or anything of that kind?—Yes. I think that the Sanitary Committee do, but mostly, I think, it is the Rivers Board who control the manufacturers.

14862. That is with regard to manufacturers who are discharging directly into the streams?—That is so, sir; yes.

14863. Do you require the manufacturers whose trade refuse you receive into the sewers; do you in any cases insist upon their having settling tanks or removing otherwise than by screening certain parts of their refuse?—I could not say definitely. I am in doubt as to that. The Sanitary Committee of the Corporation is another department. I am not quite sure whether the one that I have to deal with would go the length of insistance.

14864. (*Colonel Harding.*) That is one of the conditions, if I remember right, that the solids shall be as far as possible settled?—Removed either by screening or by settling. I ought to say where you have

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screenings it really means screening out of a chamber, in that sense, of course, yes.

14865. Would you say you have had great difficulties in getting the manufacturers to accept your conditions, or have they come in?—I do not think great difficulties. They will not until you convince them that you could, if you would, compel them. It gets to something like that.

14866. And are you in a position to do that; to threaten them in that way?—I do not know. It is a legal question, and I am rather in doubt sometimes.

14867. But it has not yet been tested?—It has not been tested.

14868. And you are acting as if in all probability it would be tested in your favour?—Yes, we are. At present I do not think it will ever need to be tested. I think sooner or later they will all make the provision we ask.

14869. (*Chairman.*) It is really a very large amount of trade refuse you have to deal with in your sewage. I mean it is a very appreciable portion of your total sewage, is it not?—One-third, I should think.

14870. And some of it is of a very distinct character; for instance, the trade refuse coming from the copper works?—Surely.

14871. (*Sir William Ramsay.*) The only question that it occurs to me to ask is, have the managers always the area on which to put down settling tanks?—You generally have to worry them into it.

14872. But have they the area? Can they do it?—I could not say. I have heard of cases where they have not area, but I have never myself come across those cases. As a matter of fact, I have not to do with that branch of the business which says whether these folks must be excused or not, but when these things are getting to the point that something is going to be done, then the mode of doing it is submitted to me; that is, the plans of the settling tanks, the screens, and so on, are submitted to me.

14873. Do you happen to know whether much pressure is put upon the manufacturers by the Rivers Board?—I do not know, but I think so. My impression about the Rivers Board is that it is a most patient and untiring body. It never gives over; it has no end of patience.

14874. So it would be easier for them to connect with the sewers than to carry out the requirements of the Rivers Board?—In many cases, I have no doubt. But I ought to say that, having a navigation, that is, the river being a navigable stream fed from the other natural streams in the city, into all of which, both the main stream and the other, waters have been from time immemorial discharged from these works, the owners of the navigation would have a word to say to any abstraction of the waters from these navigable streams or their tributaries, and putting it into our sewers.

14875. (*Colonel Harding.*) And that, in fact, Mr. Hewson, is the reason some of these manufacturers do not ask to be allowed to connect with your sewers, and they would not be permitted to do so by those who have riparian rights?—There are third parties who would say no.

Amongst others, the Aire and Calder Navigation would object.

14876-7. Then with regard to the works that we have been visiting, the Commission understands that it is not possible for the Corporation of Leeds, with its present limited area, to settle more or much more solids from the bulk of their sewage than they do now, because they have no adequate room to deal with the sludge?—Yes.

14878. And I believe that it is in contemplation, is it not, to put down some plant for burning a certain portion of the sludge by mixing it in a semi-dried state with coal and with certain oils which will assist its combustion?—Yes; that is so.

14879. You have made some experiments which are rather encouraging, have you not?—Yes, I made some experiments which so far make it very likely that we shall be able to get rid of a good portion of our sludge at a less cost than by any other means.

14880. (*Chairman.*) In burning it you may make use of it as fuel?—Yes.

14881. (*Colonel Harding.*) It has a certain fuel value, though not very much, I suppose, but such fuel value as it has would be so obtained?—As a fact, knowing that the Commission were coming, I have in the last two or three days been going into two or three other methods, one being the use of petrolite.

14882. But the schemes are not sufficiently forward to enable you to give data to the Commission?—No farther than I have said, but with regard to petrolite, that scheme looks to me the more hopeful.

14883. Then with regard to the future of sewage disposal, the whole thing is in abeyance, because the Corporation, having obtained possession of a large site, fourteen miles from Leeds, have not obtained the necessary Parliamentary powers to carry their sewage to it?—That is so.

14884. (*Chairman.*) There are difficulties, are there not, with regard to carriage in passing through an undermined country?—That is so. As a fact, the scheme has been before Parliament and thrown out, after severe opposition, one of the points of the opposition being, as you say, the carrying of the main sewer over some seven or eight miles of a mining district.

14885. Then the interest of the experiments you are carrying out in artificial filtration lies in this: that if you are unable to carry your sewage to the large site at Gateforth, you will be enabled possibly by obtaining possession of land nearer to you, to carry out the bacterial treatment which would be necessary?—Undoubtedly that is so. Having failed, so far, any way, to get a scheme which meant a large area of land, and only small settling tanks as a subsidiary, we are bound now to come nearer home, where there is practically no land; we are bound to find out a scheme which will do with the minimum quantity of land.

14886. And that is the object of the experiments which the Corporation has for carrying on?—That is so, sir; we are in search really of the minimum quantity.

14887. Is that land you have at your disposal the minimum?—I am afraid not.

14888. (*Colonel Harding.*) If only 25 acres is insufficient for any system of sewage treatment, the whole question is in abeyance until the Corporation decide to go for the Gateforth scheme or some other alternative scheme?—That is so.

14889. (*Chairman.*) You have alternatives in view?—We have the alternative of the bacterial process.

14890. I mean the alternative of land. What larger amount than your relatively small amount of land should you want to make use of for the bacterial treatment?

14891. (*Colonel Harding.*) We have no alternative. We should have to get Parliamentary powers to get land. We have no land of our own?—We shall have to go to Parliament either for the old scheme, or for a scheme having for its principal feature bacterial beds with quantity of land.

14892. (*Sir William Ramsay.*) You mean there will have to be compulsory sale?—Certainly; we shall have to get compulsory powers to purchase land nearer our works.

Mr. William H. Harrison, Chemist of the Leeds Sewage Works, called; and Examined.

Mr. W. H. Harrison.

14893. (*Chairman.*) What are your qualifications? You are a Fellow of the Chemical Society, are you not?—No.

14894. Have you any qualification?—Master of Science of Victoria University.

14895. And you are the chemist of the——?—Leeds Corporation Sewerage Committee.

14896. (*Colonel Harding.*) He is manager of the works there under the engineer?—Yes.

14897. (*Chairman.*) We have had very valuable and very complete evidence concerning the sewage works some time ago from Colonel Harding and yourself, and, therefore, I think we may confine ourselves to-day to the new facts that have come up since that evidence

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was given. Now, what have you done with regard to the double contact beds?—Since we gave the evidence?

14898. We might just refresh our memories. When you gave the evidence, what was, briefly, the history of the contact beds?—We had only tried them up to that time on the Dibdin principle; that is, crude sewage on a coarse bed, followed by a fine bed; and we got there very good effluents, but the beds sludged up to such an extent that they became unworkable.

14899. Since then?—Since then we have tried double contact, using septic tank effluent instead of crude sewage, and having two fine beds instead of a coarse and a fine bed. The result has been that we have got better effluents, and so far we have had no appreciable loss in capacity in the first bed.

14900. Am I right in saying that the loss of capacity before was in the first bed?—In the first bed.

14901. The second, which was then the only fine bed, and now is the second fine bed, has not been changed since it was originally laid down?—That is so. It has been in work now five or six years.

14902. And its capacity?—It is about 75,000 gallons.

14903. Is that pretty constant now?—Pretty constant, yes.

14904. And has been since?—Has been for the last five years. Of course it decreased a little during the first year.

14905. You throw all your effluent from the septic tank?—On to the first bed.

14906. Of course you have a large number of septic tanks?—Seven in all.

14907. Which is it from? It is not from all of them?—From all of them.

14908. You have been using them in series, have you?—No; the first three septic tanks are separate from one another.

14909. I mean, you use them together; or do yo use No. 1, then do you use No. 2, and then No. 3?—All the effluents are run together, and then pumped on to the bed.

14910. You use them in common, in fact?—Yes.

14911. Since you have been treating those two beds, both the fine beds, with the septic effluent, the effluent from the septic tanks, you have got good results?—That is so.

14912. Can you state what those results are?—Can you give us some average results?—The average result of the fine bed effluent for the past six months has been in free ammonia, ·379; albuminoid ammonia, ·065; oxygen absorbed in four hours, ·331; nitrogen as nitrates, ·885. The incubator test has been satisfactory, and the suspended solids have been ½ gr. per gallon.

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LEEDS CORPORATION SEWAGE WORKS.

AVERAGES of ANALYSES for the SIX MONTHS ending SEPTEMBER 1902.

Grains per Gallon.

ANALYSES OF	Number of Analyses.	Free Ammonia.	Albuminoid Ammonia.	Oxygen absorbed in 4 hours, at 80° F.	Nitrogen as Nitrates.	INCUBATION TEST. Oxygen absorbed in 3 minutes before Incubation.	INCUBATION TEST. Oxygen absorbed in 3 minutes, after 5 days' Incubation.	Soluble Solids.	Suspended Solids.	REMARKS.
A. Crude sewage (as pumped)	20	2·78	·669	6·64	–	–	–	75·7	41·2	
Lime, effluent - - -	20	2·53	·426	2·65	–	–	–	77·1	5·2	
Crude sewage (fine screened)	20	2·33	·643	6·73	–	–	–	75·0	42·1	
Filtrate from Leeds filter (unsettled).	5	·589	·274	2·42	·457	1·03	1·33	73·9	18·9	
Filtrate from Leeds filter (settled).	20	·506	·095	·711	·486	·264	·278	73·9	V.H.Tr.	
Filtrate from Leeds filter (sand filtered).	20	·296	·053	·427	·664	·150	·186	76·8	H.Tr.	
B. Partially settled sewage -	9	2·82	·560	5·31	–	–	–	67·0	24·2	24 hours flow - } Analyses made from average of several days' samples.
Effluent from No. II. open septic tank.	9	2·37	·435	4·29	–	–	–	62·3	16·7	
Partially settled sewage -	9	2·50	·515	3·87	–	–	–	62·8	18·9	72 hours flow - }
Effluent from No. III. open septic tank.	9	2·22	·398	3·35	–	–	–	64·1	10·3	
Crude sewage - - -	As A.	2·78	·669	6·64	–	–	–	75·7	41·2	
Effluent from open septic tanks.	20	2·28	·417	4·11	–	–	–	63·8	14·9	
Filtrate from Whittaker bed (unsettled).	4	·255	·083	·851	·733	·418	·372	67·5	4·8	
Filtrate from Whittaker bed (settled).	11	·360	·051	·390	·900	·138	·085	67·7	V.H.Tr.	
Filtrate from Whittaker bed (sand filtered).	9	·251	·045	·372	·727	·152	·187	64·1	H.Tr.	
Crude sewage - - -	As A.	2·78	·669	6·64	–	–	–	75·7	41·2	
Effluent from open septic tanks (fine screened).	20	1·99	·383	3·75	–	–	–	65·2	13·8	
Filtrate from Ducat bed (unsettled).	5	·483	·115	·961	·778	·257	·257	70·0	7·9	
Filtrate from Ducat bed (settled).	20	·432	·053	·308	·995	·058	·060	70·0	H. Tr.	
Partially settled sewage -	As B.	2·82	·560	5·31	–	–	–	67·0	24·2	
Effluent from closed septic tank.	20	2·05	·377	3·76	–	–	–	63·5	10·8	24 hours flow.
Filtrate from Cameron Plant.	20	·718	·107	·504	·626	·233	·218	63·6	2·3	
Crude sewage - - -	As A.	2·78	·669	6·64	–	–	–	75·7	41·2	
Effluent from open septic tanks.	16	2·07	·600	5·25	–	–	–	55·9	19·5	
Filtrate from No. I. Manchester bed.	16	1·26	·226	·957	–	–	–	57·9	2·7	
Filtrate from No. II. Manchester bed.	16	·379	·065	·331	·885	·109	·136	60 6	·5	

RODLEY SEWAGE WORKS.

Crude sewage - - -	20	2·87	·782	4·92	–	–	–	46·6	21·8	
Effluent from grit tank -	20	2·33	·612	3·98	–	–	–	44·2	21·3	
Effluent from septic tank -	20	1·98	·431	3·05	–	–	–	46·4	13·9	
Land filtrate - - -	20	·428	·079	·360	·028	–	–	42·1	1·2	

W. H. Harrison,
Chemist to the Leeds Sewerage Committee.

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14913. And the capacity of the first tank—has that remained constant?—It has dropped from 86,900 to 67,400 gallons, and appears to be fairly constant at the latter figure.

14914. Has been fairly constant for how long?—Nine months; nine to ten months. The loss of capacity during the summer months has not been very great. It has been chiefly during the winter months when the cold has approached.

14915. (*Colonel Harding.*) You gather then that the bacterial action is more vigorous in the warm weather?—Yes.

(*Chairman.*) We will take each item in turn about these double contact beds.

14916. (*Sir William Ramsay.*) You clean the septic tanks pretty often, do you not?—About once in two years. I think they would be better cleaned out once in 18 months.

(*Chairman.*) I was going to ask about the septic tanks. Perhaps we may deal with this first, and I was going to ask about the septic tanks after we had finished. Perhaps we had better take the septic tanks first.

(*Sir William Ramsay.*) It comes first in order.

14917. (*Chairman.*) Of course the septic tank is used for other things as well. You have septic tank No. 1. How old is that?—It will be two years old in December.

14918. Has that been cleaned out?—Yes. It has been working four years, and it was cleaned out at the end of the first two years. Since then it has nearly worked a second period of two years.

14919. And does it show signs of wanting to be cleaned out again?—Yes.

14920. It will soon have to be cleaned out?—Yes, in December; in fact, it needs it now.

14921. So that really with that tank two years is about the time it will run before it needs to be cleaned?—Yes.

14922. By cleaning, does it mean removing the whole?—Except a small portion left for inoculation purposes.

14923. Then Nos. 2 and 3 septic tanks, how old are they?—No. 2 is as old as No. 1; that is, it will be two years old in December.

14924. Two years since it was cleaned?—In December, yes. No. 3 will be two years this last period of working in January next, so that they are pretty nearly of the same age.

14925. Do they differ in any features?—Nos. 1 and 2 are working on the 24 hours flow; No. 3 on 72 hours flow.

14926. Are there any differences, any marked differences in the effluent from No. 3, as compared with Nos. 1 and 2? I suppose Nos. 1 and 2 are about the same?—They are both alike.

14927. Does No. 3 differ from Nos. 2 and 1?—Yes, the figures are lower throughout.

14928. Can you give us the figures?—Yes.

14929. You had better give us the characters of Nos. 1, 2, and 3?—I cannot give you them for No. 1, but I can give you them for No. 2:—

Free ammonia - - - - -	2·37
Albuminoid ammonia - - -	·435
Oxygen absorbed - - - -	4·29
Solids in solution - - -	62·3
Suspended solids - - - -	16·7

In No. 3 the free ammonia is a little lower.

Free ammonia - - - - -	2·22
Albuminoid ammonia - - -	·398
Oxygen absorbed - - - -	3·35
Soluble solids (rather higher) -	64·1
Suspended solids (lower) - -	10·3

14930. Do you think that result would lead you to favour the construction of tank No. 3 as compared with No. 1, or No. 2, or rather to adopt the method of treating No. 3?—You mean the 72 hours flow.

14931. Yes?—I do not think so unless it was proposed to turn the storm waters through the septic tanks.

14932. Then Nos. 4 and 5 are worked in series, are they not?—Yes.

14933. No. 4 being a small tank of what capacity?—Half a million gallons.

14934. No. 5 being much larger?—It is of the same capacity.

14935. I thought No. 5 was larger?—No. 4 is rather deeper.

14936. (*Sir William Ramsay.*) Do not you mean that Nos. 4 and 5 together represent a capacity of half a million gallons?—No. No. 4 tank consists of a new tank and one of the old tanks joined together.

14937. And the two together?—The capacity of the old tank was a quarter of a million gallons. Then there is the new tank to add on. They are rather deeper than the large new tanks.

14938. (*Chairman.*) But it is smaller in area, No. 4, than No. 5, superficial area, but it is so much deeper that it makes up in quantity?—It would be of a depth of from 7ft. to 8ft. Of course, the others would not have that.

14939. What is the purpose of having these two in series?—There are really four in series, Nos. 4, 5, 6, and 7.

14940. No. 4 runs into No. 5?—The No. 4 is a tank itself with a normal flow of 24 hours. It runs into No. 5, and thence through Nos. 6 and 7.

14941. Through No. 5 to No. 6?—Yes.

14942. And through No. 6 to No. 7?—Yes; but also coming into No. 5, there is a flow of a million and a half gallons of partially settled sewage.

14943. Which has not been through No. 4?—Which has not been through No. 4.

14944. It has a double supply?—Yes, that is so. We tried the experiment previously of turning 2,000,000 gallons through the four tanks, that being the capacity of the four tanks, but we found the sludge accumulation in No. 4 tank was so great that we had to stop it at the end of two months' trial and no septic action had taken place; so that since then we have turned the 24 hour flow through No. 4, and worked the other three in series, turning the effluent from No. 4 into No. 5.

14945. (*Colonel Harding.*) The No. 5 which Sir Michael is speaking of is in effect a separate experiment from Nos. 5, 6, and 7?—I told you that the effluent goes into No. 5.

14946. That is simply a matter of convenience?—Yes.

14947. (*Chairman.*) So far as that experiment is concerned, it is stopped, and then, as a matter of convenience, you turn your flow from No. 4 into the last series of three, and that only forms a small part of what goes through No. 5?—That is so. It is a quarter of what goes through No. 5 tank.

14948. Your data were taken at No. 4?—Yes.

14949. Then what is the result of the passage through these several tanks in series?—Practically no difference to the 24 hours' flow. I have not got any figures here for those three, but the analyses I made some time ago show there is practically no difference between the three in series taken together with the 24 hours flow and the ordinary 24 hour tank.

14950. No. 2?—No. 2.

14951. Then if there is no difference in the final result, are there any other reasons giving an advantage to this system of series?—Yes.

14952. What are they?—The greatest accumulation of sludge takes place in the first tank, and this is confined to a, comparatively speaking, very small area, which, of course, is a practical advantage in cleaning.

14953. They can be cleaned out more readily than a large tank?—Yes.

14954. So that, on the whole, supposing a system of septic tanks is adopted, the experience here would rather be in favour of having a series; at all events, a series of two?—Yes.

14955. The first one being a smaller one, which could be cleaned out very readily. Does that apply to other members of the series? You have got a series now of four?—Nos. 4, 5, 6, and 7. There is really no advantage to be gained after the third tank. I should not favour a series of tanks containing more than three tanks. The flow in them would tend to become so rapid in proportion; that is, the rate of flow would become so rapid through the tank.

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14956. And it is the effluent from the several tanks combined together that you are using for your double contact beds?—That is so.

14957. (*Colonel Harding.*) The only point I had in mind was about the double contact beds. I take it that is included in the series you are now taking. You gave us the average analyses spread over six months, Mr. Harrison?—Yes.

14958. There was no great variation in these analyses, was there? The results of that double contact filtration were very steady?—That is so.

14959. There is no wide divergence in the analyses?—No; they do not vary much. The variation is between ·04 and ·08 of albuminoid ammonia.

14960. So that in no case would they reach the provisional standard of the Irwell and Mersey Board?—I have never had a case where they reached the provisional standard since they have got into proper action.

14961. Invariably below it?—Yes.

14962. That is the whole point.

14963. (*Chairman.*) Now we may pass to the Whittaker. We had evidence concerning that on a former occasion. Have you got any new results to report with regard to the action of that since the former evidence. That is treated with the septic tank. I think the effluent from the septic tank is turned on to that?—Yes, from the open septic tank.

14964. And that gives you an effluent in which there is a considerable quantity of suspended matter?—That is so.

14965. What is the average amount of suspended matter?—About 5 grains per gallon.

14966. But that suspended matter may be removed by filtration through fine material?—That is so. Through a thin layer of clinker, as with us.

14967. It is wholly removed so, is it?—Yes, absolutely.

14968. And what is the analysis of the Whittaker effluent when this sediment has been removed?—For the past six months the average result has been ·251 free ammonia, ·045 alluminoid ammonia, ·372 oxygen absorbed, ·727 nitric nitrogen. The incubator test has been satisfactory; the soluble solids have been 64·1, and there is a mere trace of suspended matter at present.

14969. What is the composition of the suspended matter as the effluent comes from the Whittaker?—Roughly, there will be between 40 per cent. and 50 per cent. of organic matter, the rest being mineral.

14970. What is the nature of the mineral matter?—30 per cent. of it consists of oxides of iron and alumina.

14971. 30 per cent. of the total suspended matter?—That is to say, all the rest consists of grit and other similar matters washed out of the bed.

14972. Can you make any statement as to the composition of the organic matter?—I cannot.

14973. It contains, roughly, a small quantity of nitrogen, ·6 per cent.?—I should not put the amount of nitrogen down as so high an amount.

14974. But would you put it down as very low?—Rather low.

14975. As compared, I mean, with the ordinary albuminous matter?—I should put it down as equal to the nitrogen in rich soil.

14976. (*Sir William Ramsay.*) Is it nitrified?—The nitrates have been washed out in the process.

14977. Do the filter beds often want clearing?—The Whittaker beds?

14978. The filter beds of the Whittaker?—We are working them now, turning the effluent from them at the rate of 400 gallons per square yard or 2,000,000 gallons per acre.

14979. (*Colonel Harding.*) That would be 400 gallons?—400 gallons per square yard, and they last about seven weeks.

14980. (*Sir William Ramsay.*) Is there much difficulty in cleaning?—The solid matter dries very rapidly. It cracks up and separates very easily from the surface of the fine coke.

14981. (*Chairman.*) So that if you have a series of them you can use them conveniently one after another; if you have a large enough series, by the time you come back to your first one it can be readily cleaned?—Yes; in fact, it can be removed easily at the end of a month after stopping the inflow of liquid on to the area.

14982. (*Sir William Ramsay.*) Do you still heat the water that goes on to the Whittaker?—We are doing so at present, though past experience has shown that it is not necessary. It is more for convenience that it is done.

14983. (*Colonel Harding.*) You are not doing it at present?—We are doing it at present. As a matter of fact, we have not at present a pump at liberty, and are using the pulsometer really more for convenience.

14984. How long have you been using it?—Since the necessity has arisen for about 12 months.

14985. (*Sir William Ramsay.*) What rise of temperature does it give?—About 3°.

14986. (*Chairman.*) Where is the temperature taken?—At the end of the outlet pipe from the pulsometer and also as it leaves the sprinkler.

14987. (*Sir William Ramsay.*) Have you to wash out the Whittaker often?—The Whittaker bed has now been working three years and over, and we have washed it out twice during that period. This year we have not touched it at all. It has been helped this year by the very heavy washes of solids coming from it towards the end of spring.

14988. That you ascribe to the increased activity of the bacteria at the time?—It occurs periodically; we get it every spring.

14989. Would that be sufficient to keep the Whittaker clean?—Not of itself.

14990. (*Chairman.*) There is a growth on the surface?—On the top of the filter there is.

14991. Would that have to be removed?—The growth grows very rapidly towards the beginning of spring. The temperature of the sewage seems then to be at the best point, and the sewage in the best condition for its growth, and if we once clear that period we are all right for the rest of the year. We have at that time to keep continually forking the surface of the filter.

14992. (*Sir William Ramsay.*) It is proposed to put up a number of filter beds. They would all require to be separate entities, like the one you have. It would not be possible to make a large surface with a number of sprinklers on it?—I do not think the aeration of the interior of a bed like that would be sufficient.

14993. (*Chairman.*) Have you any facts to base your opinion upon?—Not with regard to aeration.

14994. What is the diameter, for instance, of a Whittaker?—I should not like to fix on any particular size, but the largest I have had experience of has been 70ft. That was properly aerated.

14995. (*Colonel Harding.*) Let me ask your opinion upon this: Suppose instead of having separate entities of 70ft. diameter, such as have been suggested, you had one long bed 70ft. wide and of 200ft. or 300ft. length, why should not that answer?—That would be sufficient to allow of proper aeration.

(*Chairman.*) I was thinking that would get over the difficulty of getting aeration in the centre of the bed.

14996. No part of the bed to be more than a certain distance from the atmosphere?—I think so.

14997. (*Sir William Ramsay.*) Is it a very expensive bed to construct, compared with the other?—It is rather an expensive bed to construct, but not very much so as compared with the others. The comparatively small area required in proportion to the others makes up for the increased cost.

14998. Is there much work required to clear the grit from the sprinklers?—That depends on the sprinkler. If the holes are small and of the same diameter, and are so placed as to give equal distribution over the bed—that is, that they become nearer to each other as they get to the outside of the sprinkler—then there is a difficulty, but if the holes are the same distance apart on the sprinkler and increase in size in proportion to the area covered, then there is not much difficulty. The pieces of material clogging the smaller holes up are washed out at the next larger holes at the next flush—that is, with the use of the Candy sprinkler where the flow into the sprinkler is intermittent.

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14999. How often do the holes require to be cleaned?—With the Whittaker sprinkler they require to be cleaned three times a day; with the Candy once a day is ample.

15000. Is that a serious item in labour; I mean taking it per acre?—Yes, it will be, over a large area of beds.

15001. (*Colonel Harding.*) The question of distribution has not occupied your attention, I take it, or that of the engineers, to a very important extent, because it was sufficiently good for these experimental purposes, but you consider probably that great improvements can be made upon the sprinkler apparatus that are now in operation there?—Oh, no doubt.

15002. They must be looked upon meanwhile as provisional?—Yes.

15003. (*Sir William Ramsay.*) I was merely thinking of what would happen when you came to apply it to 100 acres?—I am not sure you could not apply it.

15004. (*Chairman.*) Now, I think, we may turn to the Leeds filter. How long has that been at work?—We started that towards the latter end of last year.

15005. What is the diameter of that?—45ft.

15006. How is it constructed?—It is constructed of large slabs of clinker from the destructors.

15007. What is the average size of the slabs?—About 14in. across.

15008. The result of that is to leave relatively large interstices?—When they are packed vertically, as we pack them.

15009. They are packed vertically?—They are packed vertically.

15010. On the surface they are horizontal, but below the first layer they are all vertical?—That is so.

15011. Upon that you pour with the Condy sprinkler crude sewage?—Yes, after fine screening.

15012. Besides the first coarse screening at the outfall you have a fine screen?—Yes.

15013. More than one?—Yes. The screen at the outfall is a 1in. mesh. After that we have a $\frac{1}{8}$in. mesh, and then we have a 1-26in. mesh.

15014. Can you make any statement as to how much you collect at first; not at the coarse one at the outfall—you can neglect that—but at your first fine mesh screen. Perhaps you do not keep them separate?—I have taken no account.

15015. Then we will take the two together. What is the amount of sewage you take out by means of these fine screens?—About ten barrow loads a day.

15016. What does that come to, do you know?—No.

15017. Can you make a statement as to the composition of the material? All the larger matters are kept out by the coarse screen at the outfall?—Yes, and that consists of paper and rags, and things of that nature, but finer screens chiefly retain fine lengths of fibre—wool fibre chiefly mixed with small pieces of paper, tea-leaves and small detritus generally.

15018. Animal fibre?—Yes.

15019. So that you think that is a large proportion of the total which the barrow loads take away?—Oh, no; it is a very small proportion, about $\frac{1}{8}$.

15020. Is paper, then, a large proportion?—I should say small. I have really never screened the whole of the sewage so as to take out the fibre from the whole of the sewage.

15021. What is the proportion of fibre to celluloids? What is the proportion of the wool fibre to the cellulose? Can you form any rough idea?—I can only do so in this way, that we could with sufficient screening collect about 80 tons weight of wet wool fibre per week.

15022. And that it is proposed, as we are told, to burn?—Yes.

15023. Mixed with coal and some oil?—That is so.

15024. Has there been any diminution of the capacity of your Leeds filter since it was fairly started?—In that case it is not a question of loss of capacity. It is a case of preventing wire-drawing by clogging through the interior of the filter.

15025. Has there been any change in any respect?—Not otherwise than by growth forming on the top of the filter.

15026. There is a growth on the top of your filter like that on the top of the Whittaker?—Yes.

15027. As great?—Rather worse.

15028. And occurring at the same time in the spring?—Yes, but the periods extend longer.

15029. What is the nature of the growth, do you know?—I am afraid I could not say. It is a vegetable growth, in the nature of fungus.

15030. Well, now, as to the effluent from your Leeds filter, what is the composition of that? In the first place, it is turbid when it is used, is it not?—Yes, it analyses then as it comes from the filter at ·589.

15031. How much suspended matter, first of all?—18·9 grains per gallon, and that is the average for the last six months. Of course, that fluctuates very greatly. The free ammonia is ·589; albuminoid ammonia, ·274; oxygen absorbed, 2·42; nitrogen as nitrates, ·457; and the incubator test has been satisfactory during the past six months.

15032. How does that compare with your double contact bed in which you have septic tank effluent?—With the final effluent from the double contact?

15033. Yes?—It is much worse, as this contains such a large quantity of suspended matter.

15034. But taking away the suspended matter?—Then it is about the same with regard to ammonia values and oxygen absorbed; better with regard to oxygen in solution. I will give you the actual figures after sand filtration of the Leeds bed effluent. Free ammonia is ·296, as compared with ·379 in contact beds; albuminoid ammonia, ·053, as compared with ·065; oxygen absorbed, ·427, as compared with ·331; and nitric nitrogen, ·664, as compared with ·885 soluble solids, 76·8, compared with 60·6 in the contact beds.

15035. I ought first to have asked you: your effluent from the Leeds filter is subjected to an alternative treatment; one is settlement and the other is filtration?—That is so.

15036. What is the result of the settlement, and what is the nature of the settlement?—The settlement is a 12-hour flow through an ordinary form of settling tank, and the solids are retained. All the heavy solids are settled out, and what remains in the effluent is simply very fine particles giving an opalescence to the liquid. The albuminoid ammonia is reduced to ·095.

15037. A reduction over the effluent from the filter?—A reduction over the effluent from the filter.

15038. From the filter itself the further reduction is?—After filtration to ·053.

15039. What is your process of filtration? That is similar to the filtration to which you subject the Whittaker tank?—That is a layer of 6in. of very fine clinker.

15040. How long does that take to go through?—When the area is first saturated it runs through nearly at once, but as time goes on the solids collect on the surface, and the water gradually dams up.

15041. And in what length of time does a filter become useless?—In about three weeks at the 400 gallon per square yard speed.

15042. Is it equally efficacious during the whole of that time, or is it better at one time than another?—It is rather better after the first slight clogging of the surface has taken place.

15043. When it is in its best condition what is the effect on the effluent?—The effluent is clear and sparkling; quite as clear as drinking water.

15044. And in composition?—Very little different to any other time. The albuminoid ammonia might be reduced $\frac{1}{2}$ per cent.

15045. Then there is not so much effect as in the settlement tank?—There is a distinct effect in the settlement tank which is not obvious in the filtration. You said the albuminoid ammonia was distinctly lessened; was it not by mere settlement?—Yes, but in this case you get out more of the solids, and you get down to ·053. That is better still than a settled effluent, but that settled effluent is pretty constant. It does not vary very much as the sand filter clogs.

15046. When the sand filter is near its end it is producing very little effect?—Very little effect indeed, except to remove the solids. It is only mechanical filtration.

15047. Now this suspended matter in your Leeds filter is not quite comparable to the suspended matter in the Whittaker?—Not quite. It is not so well oxidised.

15048. How do you mean, not quite so well oxidised?—I mean that the oxidising effect of passing through the bed has not been so intense as in the case of the Whittaker bed.

15049. Is it still capable of putrescence?—Not as it comes from the bed and is mixed with the effluent, but when settled out as sludge the sludge is slightly putrescent, though very slightly.

15050. Is the composition about the same, does the same amount of mineral matter, the same quantity of iron exist?—The percentage of organic matter will slightly vary, but the proportion of mineral matter to the organic will be about the same. The iron is about the same percentage.

15051. The Ducat, I think, has been in operation since the last report?—Since a year last May.

15052. It has been going on since that time?—Yes.

15053. And what have you to report with regard to that? Do you use the crude sewage or the septic tank effluent?—We used the crude sewage for the first few months, but found that the sewage matters merely clogged the surface of the bed, and after a while prevented the aeration of the filter, and we got bad effluents with regard to putrescibility. We had to clean the surface of the filter about once every six weeks, and then we should get good effluents for a period, and after trying this for several periods we then commenced a year last May to turn the septic tank effluent on. Since then we have turned the septic tank effluent on without stopping in any way.

15054. And with what result?—We got very good results indeed.

15055. What is the nature of the effluents?—The effluent as it comes from the filter is similar in character to those obtained by the other continuous filters; that is, it contains a good deal of suspended matter, but when this is settled out we then get very good effluents indeed.

15056. What is the nature of the effluents?—After settling out we get ·432 of free ammonia, ·053 of albuminoid ammonia; ·308, oxygen absorbed; ·995, nitrogen as nitrates; and 70·0 soluble solids in every 70,000 parts.

15057. The matter in suspension is of the same nature as that of the Whittaker and the Leeds?—Identical.

15058. Then your conclusion is that it would not work with the crude sewage even screened. I suppose you used fine screens?—Yes; in that case the screen consisted of a layer of the bed material itself, and the sewage had to pass through this layer before passing on to the top.

15059. You have not tested the Ducat with the sewage screened by the same wire screen as is applied to the Leeds filter?—We did, but it did not answer. It collected very rapidly.

15060. How long a trial did you make of that?—It only took about four weeks in that case for the surface to clog. We found it was essential to remove the fibre from the sewage, and to do this we had to pass it through a layer of the bed material itself.

15061. You removed the fibre by means of your fine screen?—Yes, but the screen in the Ducat bed was not quite so fine as that for the Leeds filter.

15062. You have not tried the Ducat in exactly the same way as you work with remarkable success your Leeds filter?—The reason is before we tried it with the Leeds filter we were sending septic tank effluent on to the Ducat bed.

15063. But with the septic tank effluent you find the Ducat does not choke?—It has not done so.

15064. How long do you say it has been going on?—A year last May.

15065. And there are no signs of choking?—We only get local bonding on the surface of the bed.

15066. (*Dr. Russell.*) You have made an interesting colour experiment with the Leeds filter to show the rate of flow?—Yes; we added fluorescine to the sewage just before going on to the filter, and took the time of the passage of sewage from the top of the filter to the bottom.

15067. How long did you find that to be?—One and three-quarter minutes.

15068. (*Colonel Harding.*) Comparing, then, Mr. Harrison, the process of double contact treatment of the septic effluent with the process of the Leeds bed, what sort of comparative result do you get? You told us, I think, that the final effluents were not dissimilar?—No; there is very little difference indeed.

15069. Then what is the rate of flow that you can pass continuously through these double contact beds? You now fill them, I think, three times a day?—Twice a day.

15070. And what is the volume you pass? Have you reckoned it out per square yard?—Yes. Taking the area of the two filters as one area, we are treating approximately half a million gallons per acre.

15071. And in the case of the Leeds bed you are treating?—We are treating a million gallons per acre.

15072. (*Chairman.*) Twice as much?—Twice as much for the area covered by the filter.

15073. (*Colonel Harding.*) The filter is of greater depth?—In the case of the Leeds filter it is 12f. deep.

15074. Then that passed through the Leeds filter is a first process?—That is so.

15075. And how does it compare with the septic tanks as a first process? Does it give about the same amount of purification?—It gives rather more according to the averages for the last six months, but when the flushes of solids come on from the filter, of course it won't give as much as the septic tank.

15076. As an average it might be considered to give an equal result with the septic tank?—It is rather better, I think.

15077. (*Chairman.*) That is exclusive of suspended matter? The suspended matter in the septic tank is eminently putrescible?—That is so.

15078. What is the difference? Excluding the suspended matter in both cases, what is the comparison then?—If you exclude the suspended solids from the Leeds bed filter, the albuminoid ammonia is ·053. If you exclude it from the septic tank it is about ·25, roughly.

15079. (*Colonel Harding.*) Therefore the passage through the continuous bed which you call the Leeds bed gives a little better results than the septic tank treatment if in both cases you remove the solids?—If you remove the solids—yes.

15080. In both processes, getting the solids in analysis, the results are not dissimilar?—Rather to the advantage of the Leeds filter effluent.

15081. The second process following the passage through the Leeds bed, you told us, was either settlement or filtration through a layer of thin material?—That is so.

15082. Then through that second filtration you can pass at the rate of a million gallons per acre also?—2,000,000 gallons.

15083. You have no doubt you can do it at the million gallon rate?—Without doubt.

15084. So that in both cases, the first and the second process, you have the ability to pass a million gallons per acre?—Yes.

15085. And that is rather an advantage in some cases over the double contact filtration, because you could, if compelled, work on a smaller area?—Oh, yes.

15086. (*Sir William Ramsay.*) What would be done with the increase from storm waters?—At present I should propose turning the excess on to the filter.

15087. It would stand it?—It would help to remove the solids as well. It would flush them out.

15088. (*Colonel Harding.*) You have tried some experiments in washing out at Leeds, and you believe that washing out would be accomplished by the storm overflow during storm time?—That is so. Then we get an effluent quite black with suspended matter.

15089. (*Chairman.*) When you have washed it out in that way from the filter, what is the composition of the effluent that you have? You have removed the suspended matter; you have it washed out?—The effect of washing is to make the effluent rather worse than it was previous to the washing for a short time.

15090. How much worse?—Can you give me any figures?—Trusting to memory, it will increase the albuminoid ammonia ·05 to ·09.

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15091. After washing?—After washing. The bed is certainly very much worse after washing out.

(*Colonel Harding.*) Do you gather that you have washed out some of the bacterial life?—Yes, you have disturbed it altogether by the comparatively rough treatment it has had in removing the solids.

15092. (*Chairman.*) I mean, if you had frequent storms, and you were to turn your storm overflow on to your Leeds filter, you would have an inferior result throughout the year?—I do not think so, because with storm waters you would not anywhere approach the flow through the filter that you would have in washing it out.

15093. (*Colonel Harding.*) In artificial cleaning out, you would have a flow probably twenty times larger than the normal flow?—In cleaning out we should have a flow quite twenty times greater, if not more, and with any storm water you would not have above six times the flow.

FIFTY-FIRST DAY.

Wednesday, 22nd October, 1902.

BRADFORD.

PRESENT:

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P. (*Chairman*).

Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Colonel T. W. HARDING, J.P.
Dr. JAMES BURN RUSSELL.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary*.

ALSO PRESENT—

Dr. A. C. HOUSTON.
Mr. COLIN C. FRYE.

MINUTES of EVIDENCE taken at the Bradford Town Hall after the visit of the Commissioners to the Bradford Sewage Works at Frizinghall.

Mr. J. Garfield and Mr. R. Johnson.

22 Oct. 1902.

Mr. JOSEPH GARFIELD, Engineer of the Bradford Sewage Works, and Mr. R. JOHNSON, Chairman of the Public Health Committee of the Bradford Corporation, called; and Examined.

(*Chairman.*) I just want to put on record, Mr. Garfield, some of the facts that have come before us to-day. I do not think you have anything special to tell us, have you, Mr. Johnson, with regard to the details? Mr. Garfield will give us that. We want to put it on record?

(*Mr. Johnson.*) I have not, Mr. Chairman. Nothing more than I gave before the Commission on the 1st July.

15094. What we want to put on record are the facts with regard to the treatment of the whole of the sewage by acid, which has been going on now since——?—(*Mr. Garfield.*) 13th August last.

15095. How much sewage are you dealing with?—About 12,000,000 gallons a day.

15096. First that is thrown into tanks—detritus tanks—from which you remove the detritus by——?—A bucket grab. We remove about ten cubic yards a day of detritus.

15097. Which you sell?—Well, we give it away.

15098. Then it is your intention that the fluid from which the detritus has been removed should be passed through screens?—That is so.

15099. But at present?—Only a portion of it is passed through an experimental screen.

15100. Experimental screens after you have added acid?—Yes.

15101. Then, supposing that the material would have passed through the screen, you will continue what you are doing now, adding acid to the total sewage?—That is so.

15102. The actual amount which you add at any particular time varies?—Varies according to the sewage.

15103. On an average?—The actual figures are that from 130 tons, the lowest, we have gone up to 200 tons per week of brown oil of vitriol.

15104. The sewage which is treated by acid is passed into settling tanks?—Yes; into twelve settling tanks.

15105. Can you just briefly describe the story of those twelve tanks?—The twelve tanks, each of a capacity of a quarter of a million gallons, giving a total capacity of 3,000,000 gallons, receive a normal flow of 12,000,000 gallons. The tanks can be worked either separately or in series, and a series can comprise any number up to twelve. The precipitation takes place rapidly, fairly rapidly, and some 95 per cent. of the suspended matter is removed in those tanks.

15106. What is the usual time for precipitation to take place?—The theoretical time is six hours, but I think most of it has to take place in about three hours—the time of passage through the tanks.

15107. Then can you make any statement as to the composition of the effluent?—The effluent is highly polluting.

15108. First of all, with regard to re-action?—The re-action is always acid, except on Sundays.

15109. What is the limit of acidity which it reaches?—The average has been 12½ grains per gallon of sulphuric acid.

15110. The suspended matter which still remains?—The suspended matter which still remains is from 7 to 14 grains per gallon.

15111. Oxygen absorbed?—About five grains per gallon.

15112. The albuminoid ammonia?—That varies very considerably. It does not vary at all in proportion to the oxygen absorbed. The oxygen absorbed figure is obtained from a sample collected every hour, night and day.

15113. What are the ranges of the albuminoid ammonia?—I have not the figures here, Sir Michael, but I can give you one figure perhaps. It was one grain per gallon on October 1st.

15114. So that the total amount of purification of that crude sewage amounts to ——?—If you take it on the oxygen absorbed figure it is 50 per cent.

15115. Do you know the amount of dissolved solids and especially of inorganic solids, in your effluent?

They are considerable, are they not?—They are very considerable, yes. They amount to as much as 200 grains per gallon, the total dissolved solids.

15116. 200?—200 grains per gallon.

15117. Do you know what they are chiefly, a large quantity of potash, I presume?—Yes; there is a large quantity of potash and a large quantity of soda.

15118. And that is discharged into the beck?—That is discharged into the beck.

15119. Then your sludge amounts to how much per day?—About 400 tons of wet sludge.

15120. That is taken from ——?—From the precipitation tanks.

15121. By suction?—By gravitation and compressed air, and afterwards forced by compressed air to the sludge filter presses and elsewhere.

15122. When you began in August, was that taken to the benzine apparatus, or in part only?—A part, something like 30 tons, has been taken to the benzine apparatus since May last—April or May. The benzine extraction apparatus was working from March till 30th August.

15123. And that has been given up now?—The plant is about to be removed to France. For the next three weeks they will experiment with the pressed sludge.

15124. In the meanwhile, what are you doing with this sludge. You are taking some of it into your presses?—Some of it into our presses.

15125. How much, what proportion?—Only a small portion.

15126. It is an experiment?—It is an experiment, yes.

15127. The rest you are carrying away?—We are depositing it on the land round about the works.

15128. How much are you taking for experimental purposes?—Yesterday we took 60 tons.

15129. What process are you subjecting that to?—It is acidified with sulphuric acid, and heated up to boiling point, forced by compressed air into the filter presses, where it is compressed into a cake, part of the grease which it contains is removed, passing away in the effluent liquor.

15130. What proportion of the fat goes away in the liquor?—Less than one-third.

15131. So that two-thirds remain in the cake?—At least two-thirds remain in the cake.

15132. And what at present are you doing with the cake?—We are burning the portion that we are disposing of.

15133. Do you find it available as fuel?—From the experiment made last week I find it to be worth about 2s. 6d. a ton as fuel.

15134. What further are you doing with the liquid effluent containing the one-third of the grease. Are you treating that?—The liquid.

15135. The liquid which is squeezed out?—That contains very little grease. It is very strongly acid. That comes back into the crude sewage for re-treatment.

15136. And from the press there is squeezed out a fluid which contains one-third of the fat which was present in the sludge?—That goes into small settling tanks, where the fat rises to the top and is collected. The acid liquor passes away into the crude sewage for re-treatment.

15137. And have you been able to attach any value to that fat?—Judging from the value of the fat extracted by the solvent process, it is worth about £8 or £9 a ton.

15138. Have you sold any of it?—I have not sold any of it.

15139. And then you have made, have you not, experiments as to further purification of the precipitation tank effluent?—We have.

15140. Which is, as you say, distinctly acid in character, often rising to a very considerable amount of acidity?—Yes.

15141. How long have you been carrying on experiments with that acid tank effluent?—Since May last.

15142. Can you state what experiments you have carried on in reference to it? You had a filter previously existing?—The filter we have experimented with for the whole of the time was constructed about two years ago, and up to May last was treating an alkaline effluent.

15143. The filter was one of fine coal, was it not?—Of fine coal.

15144. With a depth of five feet?—Five feet.

15145. And how did you work that?—The effluent water was discharged on to it 24 times during the day. At mid-day the discharge would take place about every twenty minutes and at midnight about every two hours; the times of the discharges were calculated from the variations in the rate of flow of the whole volume of sewage.

15146. So that the filter had from 20 minutes?—From 20 minutes to two hours' rest.

15147. Can you make any statement as to the time it took for the fluid to pass through the filter from the top to the bottom?—No, I can only say that it was about from five to nine minutes after the flush went on that the volume of discharge from the filter was very much increased.

15148. The filter was uniform, I think, throughout, and not graded?—Uniform throughout.

15149. Except some larger pieces at the bottom?—That is so.

15150. Can you state what result you got with your filter when you worked it with your acid effluent, because that is the point we are interested in. It had been at work for a long time with alkaline effluent?—Yes.

15151. And in May last was it?—In May last.

15152. In May last you began to use it for your acid effluent?—That is so, and since then we have found the acid effluent passed much more freely through the filter, or rather the filter did not choke so much as with an alkaline effluent.

15153. You had found it previously to choke up with the alkaline effluent?—Yes.

15154. Was it actually disused at the time you began to use it for acid effluent?—We were not using it at the time. It was very much choked up. It might have been standing a week or a fortnight.

15155. Can you give us any statement of the amount of purification you have obtained by that filter during the period?—I have not many figures with me, but I have one result here. The albuminoid ammonia was reduced 87 per cent. compared with the crude sewage, and the oxygen absorbed 86·5 per cent. The oxygen absorbed was 7·5 in the tank effluent and 1·6 in the filter effluent. These are grains per gallon.

15156. Is that one of your best results?—That is the only result I have here. I was not prepared to give evidence before the Commission.

15157. But, from your general memory, that is very fair?—That is a fair result. The oxygen absorbed is generally more than one grain per gallon.

15158. Then you have quite recently, within the last fortnight, instituted a new filter?—We have.

15159. A similar, but a finer filter?—Made of practically the same material.

15160. With a similar depth of 5ft.?—With a depth of 5ft.

15161. What has been your result from that?—The first result I have was, that in the first effluent that came from the filter, the oxygen absorbed was $5\frac{1}{4}$ grains per gallon in the tank effluent, and $\frac{1}{2}$ grain per gallon in the filter effluent; the free and saline ammonia, 2·8, was reduced to 1 grain per gallon. The albuminoid ammonia, ·17, was reduced to ·14. That was taken on the 9th October. On the 11th October the results were as follows: It was evidently after rain the sewage was more dilute. 2·4 grains per gallon of oxygen absorbed was reduced to ·24, free ammonia was reduced from 1 grain per gallon to ·36, and albuminoid ammonia from ·43 to ·048.

15162. Did you test the alkalinity, the reaction of the effluent from the filter?—Yes. It was exactly the same as the tank effluent going on to the filter on October 9th. It was slightly on the alkaline side, but practically neutral. On October 11th the tank effluent gave $1\frac{1}{2}$ grains acidity, the filter effluent being 5 grains alkalinity.

15163. But, as a rule, the fluid you throw on to these filters is acid?—Yes.

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15164. But on this occasion it was neutral?—It was neutral on October 9th.

15165. Now, with your old filter the effluent thrown on to it was distinctly acid?—Tank effluent distinctly acid.

15166. And that has come out, has it, at the bottom of the filter, the effluent from the filter, as an alkaline reaction?—Yes, quite alkaline. I have here just one result. The acidity of the tank effluent was equal to 7·8 grains per gallon, sulphuric acid. The alkalinity of the filter effluent was equal to $1\frac{1}{2}$ grains sulphuric acid.

15167. That is just on the alkaline side of neutral; that was after that filter had been used with an acid effluent from the tanks for some considerable time?—Yes; these samples were taken in September, September 17, and the filter had been used since May with acid effluent.

15168. May I ask, you have in charge not only these works, but several other works?—I have.

15169. What steps do you take with regard to the procuring of the samples and their being analysed? They are not analysed by yourself, naturally?—No.

15170. By whom are they analysed?—The city analyst does the analytical work, Mr. Richardson.

15171. What steps do you take with regard to the collection of samples?—Well, in many of the works I am afraid they are rather neglected.

15172. I mean these particular samples, for instance, the results of which you have given?—Those samples are taken by the workmen. They take samples every hour for 24 hours.

15173. By the ordinary workmen of the place?—By the ordinary workmen.

15174. (*General Carey.*) Have you told us what amount of grease is contained in the sewage before it enters the precipitation tanks, and what amount is deposited in the tanks by the treatment?—No; I think I have not told you. I have one case here where the average was 47 entering and 14·7 going away.

15175. In the tank effluent?—In the tank effluent.

15176. Have you had any further results after filtration with the experimental filters?—Yes. In the case of one sample taken from that new coal filter, 15 grains per gallon went on to the filter and 5 grains came off the filter.

15177. Of grease?—Of grease. I should not actually like to say it was grease. The examinations of these small quantities of greasy matters in these waters is very different indeed. I am giving the Committee a general impression. I should not like to say that these figures are absolutely reliable.

15178. (*Chairman.*) There is one question I should have liked to have asked you, which I think I did not. What is the capacity of this new coal filter which you have put up?—The area is 12 square yards.

15179. The diameter is——?—12ft.

15180. And how much sewage can you treat adequately per diem with that?—Well, I should not like to say how much we can treat to give a satisfactory effluent. Of course, that all depends on the standard required. I am treating now at the rate of about 50 to 60 gallons per square yard per day.

15181. And that so far has given you what result?—In the case of the old filter the oxygen absorbed is above 1 grain per gallon; in the case of the new filter it is for the present below that. I expect that it will get above in a short time.

15182. It is not the average?—It is not, I think, the permanent figure that we shall obtain.

15183. It is not the provisional standard of the Mersey and Irwell Rivers Board?—The old filter does not satisfy them, but the new one at the present time does satsfy them upon that. It is 50 per cent. below it.

15184. But, of course, you are not able to say that it will be permanent?—One may expect that it will rise above 1 grain per gallon.

15185. But you can treat 50 gallons to the square inch?—50 gallons to the square yard.

15186. (*Colonel Harding.*) You would expect better results from a deeper bed, would you not?—Yes, perhaps one could obtain better results, but with a deeper bed perhaps we should have to have a coarser material, and then the contact of the material in the filter would not be so long. Of course, that is a matter of experiment.

15187. (*Chairman.*) Do not you find a difficulty? I mean you have to trust to the ordinary workmen to take samples, and all the samples have to be sent up to Mr. Richardson for analysis. In your judgment would not the possibilities in the future be very much expedited if you had a chemist on the works?—It would be a great advantage to have a man who not only would see to the taking of the samples, but would do the analytical work on the spot.

15188. (*General Carey.*) Is it the intention of the Corporation to proceed with further experiments, or to be content with results that they have got already?—In connection with precipitation?

15189. The tank effluent in connection with filtration.

(*Chairman.*) That is a question for Mr. Johnson. Perhaps Mr. Johnson would like to answer that.

(*Mr. Johnson.*) I think it is the intention of the Committee to proceed to make an application to Parliament for land to treat the sewage, but they do not propose to make an application to next year's Parliament. They have under consideration an application, and during the next few months every effort will be made by the Committee to come to terms privately, so that when we go to Parliament it will be an unopposed Bill.

15190. Are you quite clear what you are going to do with that land when you have obtained it?—Yes; I think we should proceed to lay down certain tanks and bacteria beds.

15191. Of what kind, what size?—That is a very difficult question, and one which the engineer would be better able to answer than I am.

15192. (*Colonel Harding.*) I take it the Corporation of Bradford is about to carry on systematic experiments?—They have been doing so for three years, and they will continue these until the very moment when they have to go to Esholt.

15193. (*Chairman.*) By this system you have adopted of using acid for the purpose of extracting grease you have produced, you see, on a very large scale what is quite unusual, a distinctly acid effluent, and most of the systems which are used in various parts of the country are based on having to deal with an effluent which is either neutral or alkaline, so that you have before you a problem specal to Bradford?—We quite realise that, Mr. Chairman, and that was one reason why Mr. Garfield changed the contents of the present bacteria bed with a view to ascertain reliable results. You may depend upon it that the Committee will take every step to obtain reliable information.

15194. You are now in a position, I mean it is quite possible that later it may be found necessary to produce a similar acid effluent for the extraction of grease or other purpose—you are now in the position to acquire most valuable knowledge as to the proper way of treating an acid effluent?—Yes, we fully realise that, and we shall take every step to obtain reliable information.

15195. I mean you can do that at a much less expense than would be necessary if new plant were erected elsewhere to solve that problem?—Yes, that is so. We devote part of our works at Frizinghall to carrying out experiments, and I may say that some of the experiments which we have carried out have been of great value to us. For instance, we tried for nearly twelve months the method of using the tanks in series in the old works before we put down our present twelve tanks, which was of the greatest value to us, and enabled us to get very dense sludge as well as a very good effluent, better than we were otherwise able to get with the previous method, and the Committee are desirous, I am quite sure the Committee are unanimous in carrying out such experiments in that part of Frizinghall as would guide them whenever the time comes to go to a larger area.

15196. (*Colonel Harding.*) The Corporation quite appreciates that the settlement process which we have visited, and which is so useful, cannot be considered final?—Yes, I think the Corporation realise that they will have to do more with the sewage than they are doing at the present time. I do not think there is any

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question about that in the Council. (*Dr. Russell.*) Did I understand you to say that there was less sludge with the filters? (*Mr. Garfield.*) Less sludging up of the filters.

15197. What observations did you derive that inference from?—In working with an alkaline effluent it was necessary to stop the filters three or four days every week to give them a rest, but working with an acid effluent we have been working continuously since May, and that necessity has not shown itself in any case.

15198. Is there anything in the constitution of the effluent compared with alkaline to which you would attribute that effect? Is there more grease present in the one than in the other?—No, I should not attribute it at all to the quantity of grease in the effluent, but it is very difficult at this stage to attribute it to anything in particular; but it appeared to me from casual observation that with the alkaline effluent it was a fungi growth that choked the filter; we do not find that so much with the acid effluent. Of course, all the information that I have given to the Commission is only really preliminary. There is nothing decisive or definite in any sense in any of the experiments that have been made.

15199. You regard it as a very important observation, and worth taking a deal of trouble to establish on a firm basis?—I consider it an exceedingly important observation, that.

15200. And probably you would propose to investigate it with great accuracy?—Yes, that will be done, sir.

FIFTY-SECOND DAY.

Thursday, 23rd October, 1902.

BURNLEY.

PRESENT:

Sir MICHAEL FOSTER, K.C.B., F.R.S. M.P. (*Chairman*).

Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Colonel T. W. HARDING, J.P.
Dr. JAMES BURN RUSSELL
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary*.

ALSO PRESENT—

Dr. A. C. HOUSTON.
Mr. COLIN C. FRYE.

MINUTES of Evidence taken at the Bull Hotel, Burnley, on the occasion of the visit of the Commission to the Burnley Sewage Works.

Mr. GEORGE HENRY PICKLES, A.M.I.C.E., Borough Surveyor, and Mr. RAYMOND ROSS, Borough Analyst, called; and Examined.

Mr. G. H. Pickles, A.M.I.C.E. *and Mr. R. Ross.*

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15201. (*Chairman.*) You are the Borough Surveyor, Mr. Pickles?—(*Mr. Pickles.*) Yes.

15201*. In the whole borough you have two sewage works?—Yes. The Duckpits drainage area and the Altham drainage area.

15202. The Duckpits being much the larger of the two?—Much the larger.

15203. What is the present population of Burnley?—97,044.

15204. And the acreages of the two watersheds?—Duckpits 2,800, Altham 1,215, making a total of 4,015.

15205. It is Duckpits that we are going to visit to-day?—Yes.

15206. They are both on the same plan; the same system is adopted in both?—Yes, the same system.

15207. So that we may confine ourselves perhaps to Duckpits. There is nothing special about the other one to which you wish to call attention?—No; we are simply carrying out the same system as has been adopted at Duckpits.

15208. Will you state very briefly the history of your installation?—From the commencement?

15209. From the commencement, very briefly?—In the first place the works were let to the Scott Sewage Purification Company.

15210. What works?—The Duckpits works.

15211. They were in existence then?—They were in existence then. They were really ordinary settling tanks, and the company took the works and undertook to treat the sewage for a certain number of years, and they attempted to make cement. The sludge was taken out of the works and roasted on plates, and, of course, the result was a nuisance.

15212. They failed?—They failed.

15213. What was the next step then?—There was no attempt at that time to purify by means of filters or land. Then the works came into the hands of the Corporation, and they increased the tank capacity, and acquired land half a mile lower down the river for the purpose of treating by means of chemical precipitation and land filtration.

15214. What year was that about?—1890 or 1891.

15215. That was found ineffectual?—Yes; those works were carried out, and the works were completed about 1895-96—that is, the whole of the land was laid out at that time—well, with the exception of three acres across the river. The tank capacity at that time—in fact, at the present time—is 1,273,000 gallons. That was after the capacity had been increased, and of the 63 acres of land which had been acquired for the purpose of filtration, 60 acres were laid out, giving a net filtration area of 40 acres; of course, the rest was taken up in banks and roads, and there is an isolated plot across the river, three acres in area, which has not been dealt with.

15216. That, again, did not prove satisfactory, that arrangement?—No, sir.

15217. And it was in 1897 that you commenced your present system?—Yes. I might explain that in connection with the land filtration, the scheme which was approved by the Local Government Board provided for the subsoil drains being laid 22 yards apart. In order that the land may deal with more sewage, we re-drained the whole of the beds which had then been laid out, and we put in two intermediate subsoil drains, making the under-draining $7\frac{1}{3}$ yards apart instead of 22 yards, and the whole of the 40 acres was laid out and under-drained in that way. Still, we could not deal with above one-quarter of our dry weather flow. The rest of the clarified effluent had to be turned direct into the stream.

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15218. For precipitation you were using alumino-ferric as a supplementary precipitant?—No, sir; alumino-ferric was tried for a short time at the commencement of the works, and then we used lime and copperas.

15219. And then subsequently you used ferrozone for a short time only?—Yes, but that was in connection with the polarite filters. I may say when we found the land had failed, in order to aid the land it was decided to put down four polarite filters on the International Company's process as an experiment, and those were constructed, and the company advised that we must change our precipitant to ferrozone.

15220. How long did you use this?—Three months; and we found that the precipitant bill was running up from £800 a year to about £3,000—in fact, at the rate of over £3,000; but that was not the whole difficulty. The sludge began to boil up in the tanks, and, in fact, we got incomplete precipitation. The sludge was going down the effluent channel on to the beds and ruining the beds, so that we had to abandon the ferrozone altogether as a precipitant.

15221. Then, notwithstanding that, you made these various attempts to treat your sewage partly by precipitation and partly by land, and those were unsatisfactory?—Yes.

15222. And you determined in 1897 to begin with experimenting with bacterial beds?—Yes. I might say in connection with the land that it was not worked on any rule-of-thumb basis; it was not left to the manager at all. Analyses were taken from the whole of the beds, and the beds were given proper rest, so that they should not become sewage sick, because we thought that it was better to deal with what sewage the land could treat effectually rather than turn a lot on and get a bad effluent. Of course, the rest, the three-quarters of the daily flow, was discharged into the river without any attempt at treatment.

15223. Then so much as was thrown on to the land was effectively treated?—Yes.

15224. But you were unable to treat the whole of your sewage in that way?—Yes.

15225. Only a small portion?—Only one-fourth. I might say that our dry weather flow at Duckpits is 2,000,000 gallons.

15226. Then will you state what you have done with regard to these bacterial beds?—Of course, after giving the polarite a proper test, and finding it a complete failure, we had to consider some other scheme, and at that time Mr. Dibdin had issued his report, and we decided to experiment on bacteriological lines, and we constructed two filters, each half an acre in area. One was constructed of the ordinary clinker, what we call engine ashes here, with no grading or screening; the other was constructed of coke, lumps of coke $2\frac{1}{2}$in. or 3in. in size, and these commenced working in January, 1898. Of course, we thought at that time that one contact would probably deal with our sewage.

15227. Then you are using these two beds, each of them as one contact, although they were different in structure?—Yes, as first beds, and in conjunction with precipitation by lime and copperas.

15228. How much sewage did you throw upon these contact beds—what proportion of your sewage?—Well, we found that they were treating somewhere about between 30 to 40 gallons per square yard. Of course, when they first commenced working they were treating far more, but gradually the capacity went down, and subsequent gaugings showed that they would only average about 29 gallons.

15229. Then in 1898 you were treating a certain quantity of your sewage in this way, first precipitating with lime?—Yes, lime and copperas.

15230. And then you were throwing that upon one or other of these two beds?—Yes; I might say that the effluent from these beds was so arranged that it could be discharged over land filtration areas.

15231. You were first using lime and copperas for these two single contact beds, and then land filtration?—Yes.

15232. And how long did that continue?—Well, it continued for about three years—two to three years—and then we decided to experiment with open septic tanks.

15233. Was the result satisfactory of those three years, the experience of those three years?—Yes, as far as it went; but the effluent from the beds was not sufficiently purified to discharge into the river, but we found that a second contact would probably purify it still further, so we experimented in that direction. We got a box a cubic yard in capacity.

15234. You made certain experiments with having a second contact bed?—Having a second contact bed.

15235. And the result of that experiment was sufficiently good to justify you doing it on a larger scale?—Yes.

15236. And when did you begin your second contact beds?—It would be about May, 1898.

15237. Then still maintaining your lime and copperas precipitation, you used the second contact bed in addition to your first one?—Yes.

15238. Well, and what were the results of that?—They were perfectly satisfactory. The effluents from the second bed were very good.

15239. And could be discharged at once into the river?—Yes.

15240. So as to render your land treatment unnecessary?—Of course, if we had been able to treat a sufficient quantity, it would have been unnecessary. The quantity we were treating was very small.

15241. Then what was your next step?—We put down two second contact beds of fine material adjoining the river, and discharged the effluent from one of these first contact beds, and bed on to it, and the effluent from the second contact bed was discharged direct into the stream, and in no case, I think, has there been an unsatisfactory effluent. We have had no reports of any.

15242. Then what were the next steps you took? You were only treating, of course, a small quantity of sewage in this way?—A very small quantity. The next step was to experiment with open septic tanks.

15243. What led you to do that?—We thought that in the first place the beds were perhaps clogging up with lime. The analyst at that time thought that the clogging was perhaps due to the lime.

15244. Was your sludge troubling you at all at that time?—No; we had no difficulty in geting rid of the sludge. We experimented with two of the end tanks upon the open septic principle, and one was filled for 12 hours and the other for 24, and analyses were taken of the tank effluents, and the analyst at that time reported that there was very little difference. Then it was decided to convert the whole of the tanks to the open septic principle, and that system is working to-day.

15245. Can you describe exactly what it is, your present system. How many of these septic tanks have you?—We have twelve septic tanks, with a total capacity, as I said before, of 1,273,000 gallons. The sewage on reaching the works flows through ordinary screening chambers. We have mechanical screens, mechanical rakers, and the sewage must pass through three screens, the first with a $\frac{3}{4}$in. mesh, the second $\frac{1}{2}$in., and the third $\frac{1}{4}$in., and sufficient lime is added to make the sewage neutral.

15246. Your sewage is naturally acid, is it?—Not always; it is sometimes. (*Mr. Ross.*) We get acid from the dye works, and the men down there could not control it sufficiently, so it is just as well to have a slight excess of lime at all times. It is unnecessary to add lime if the presses are working, because we conduct the liquor to the press inlet. (*Mr. Pickles.*) As it enters the works, the sewage passes through these screens, $\frac{3}{4}$in., $\frac{1}{2}$in., and $\frac{1}{4}$in., and then goes into the tanks, and is delivered by a sealed inlet, and then after passing through the tanks—the tanks are worked separately, by the way—it passes out of the sealed outlet.

15247. What is the rate of flow through the tanks?—At present the tanks will have an average of about eight hours flow.

15248. For each one of them?—Yes; we consider our present tank accommodation quite insufficient, and, in fact, there was a Local Government inquiry, with a view to doubling the tank capacity.

15249. Perhaps, before we go on, I ought to have asked you what is the nature of your sewage. The total volume you are dealing with you say is——?—A dry weather flow of 2,000,000 gallons.

15250. That is in large measure domestic sewage?—Yes, we are almost entirely on the water-closet system.

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15251. (*Dr. Russell.*) That proportion applies only to the Duckpits?—Yes.

15252. (*Chairman.*) We are confining ourselves now entirely to the Duckpits?—I might say that our sewage is exceedingly strong, as we have 15,000 slop water closets. I think you will know the ordinary slop water closet, the Ducket's, and so on, in addition to about 8,000 clean water in the borough, so that our sewage is exceptionally strong, and we get very little manufacturing effluent in the sewers.

15253. Very little?—Very little.

15254. You have some?—We have some.

15255. Of what nature?—There is one very small tannery. We have two dye works. Those dye works discharge into the sewers by agreement. One discharges at the present time not more than a maximum of 5,000 gallons per day.

15256. Uniformly or irregularly during the 24 hours?—Well, uniformly. We have control of the discharge.

15257. You have arranged that it should be uniform?—Yes.

15258. Have they any settling tanks on the works?—They have settling tanks.

15259. Is it very highly coloured, their effluent?—Yes.

15260. Does it give you much trouble in point of colour?—We find no trouble.

15261. Then breweries?—We have practically no brewery waste.

15262. And the large paper works do not discharge?—No, sir; they treat their effluent separately, and discharge into the river.

15263. What is the general composition of the sewage?—(*Mr. Ross.*) It runs somewhere about 4·7 or 4·8 parts per 1,000 of free ammonia, 1·5 to 2 albuminoid ammonia, 130 to 180 of total solids, and an average of about 36 of suspended matter, which is nearly all organic.

15264. Nearly all organic?—The average is 4 of mineral matter and 32 organic.

15265. You do not suffer much from ?—No, sir.

15266. The reaction is from time to time very distinctly acid?—Yes, sir, from time to time, when the dye liquor comes down.

15267. (*Colonel Harding.*) Have you the oxygen-absorbed figure?—Not for the raw sewage, but I can tell you roughly what it is. It would run to somewhere about 15—14 to 15, I should think, in dry weather.

(*Chairman.*) What do you do with your storm water?

(*Mr. Pickles.*) We have a separate system for the disposal of the surface water, which falls on the front streets and the fronts of the houses, by which it is discharged into surface drains, and discharged into the river, and that which falls on the backs of the houses, in the yards and back streets, goes into the sewers.

15268. What increase do you get of your sewage in severe storms?—Do you mean the maximum increase?

15269. Yes?—I think we get between five and six dilutions, except in a very exceptional storm. That is only in severe storms. I think on the average we do not get above two or three dilutions.

15270. And that goes into your tanks with the rest?—Yes.

15271. You have no separate storm overflow?—We have storm overflows in different parts of the town, and there is one storm overflow adjoining the works.

15272. What does that take off?—It takes off from four to five dilutions—a little over four.

15273. Very good. Now we may return, I think, to your system. We were speaking of these tanks, and of the rate of flow through the tanks, through your septic tanks. Now, I will ask the borough analyst what is the constitution of the tank effluent?—(*Mr. Ross.*) Well it will run about 0·8 in dry weather of albuminoid ammonia, and about 5·0 of free ammonia. The oxygen will run somewhere about 8 or 9 or 10. Of course, very often it gets down as low as 4, somewhere about that, and the chlorines run between 9 and 11, sometimes getting a little higher. The oxygen absorbed varies very much, from 4 to 12, you may say, on an average. The sewage is very concentrated. The suspended matter that is generally coming from the tanks is about 11 to 13. We have all these figures.

15274. Well now, will you describe how you work your contact beds with the effluent from your septic tanks?—(*Mr. Pickles.*) The effluent, after leaving the tanks, runs down a conduit to the farm, which is about half a mile lower down than the works.

15275. There is half a mile distance between your septic tanks and your contact bed?—Yes.

15276. Runs down by gravity?—Runs down by gravity, and is discharged on to the first contact bed until the bed is full.

15277. How long does it take filling?—They vary from an hour to two hours. (*Mr. Ross.*) It is 3½ hours for the largest beds. (*Mr. Pickles.*) Of course, they vary considerably in size.

15278. Then it is held up in the bed for how long?—Two hours.

15279. And the time of discharge?—It takes about an hour and a-quarter to an hour and three-quarters.

15280. Leaving a period of rest before it is used again of——?—Two hours. (*Mr. Ross.*) Three hours before it is used again, and sometimes it is more. (*Mr. Pickles.*) Perhaps the evidence as to the periods of rest might be taken from the analyst.

15281. Very well. Will you proceed with your description then?—Then the effluent from the first contact beds is run by gravitation on to the second contact beds, and those are worked in a similar manner, and the effluent from the second contact beds is discharged direct into the stream without any further treatment.

15282. And how long have you been working these beds now?—The first bed, the clinker bed, was put down in 1898. It commenced working on January 25th.

15283. With the septic tank?—No, sir.

15284. I am speaking now of the present system, with your septic tanks and your double contact beds?—The experimental septic tanks commenced working in 1897.

15285. But your present installation of septic tanks and double contact beds; how long has the whole system been at work?—I have not the exact dates. I think it is three years.

15286. I mean roughly?—Three years. That is, since the whole of the septic tanks were converted.

15287. And what has been the history of your contact beds since then? Have you estimated their capacity at intervals?—Yes, sir, and we find that we can deal with 29 gallons per square yard of filling. Of course, the beds are one yard deep.

15288. How many beds have you, how many first contact beds?—We have at present 6·44 acres first contact and 4·01 second contact, giving a total of 10·45 acres.

15289. I do not quite understand what that is.

15290. (*Colonel Harding.*) Acres?—I beg your pardon. You see, the beds are considerable in size.

15291. (*Chairman.*) How many first contact beds have you altogether?—We have eight first contact beds.

15292. Varying in size. What is about the smallest?—Well, they vary, with the exception of the brick filters, ½ acre to 1¼ acres.

15293. Then your second contact beds?—The second contact beds are seven in number, and those are about half an acre each.

15294. They are more uniform?—Yes.

15295. Three and a-half acres altogether?—It comes to nearly four acres really.

15296. Do I understand that in no case have you suffered from any considerable diminution in the capacity of the beds?—Well, a cubic yard, when it is first put in, I find will hold 88 gallons, whereas when it has been working for a period extending over 18 months to two years we find that we can maintain 29 gallons per filling, so that it is reduced about two-thirds.

15297. Is the reduction going on to your knowledge in any of your beds?—No, sir. We believe from our experience we can maintain it at that, or about that.

15298. (*General Carey.*) Eighty-eight gallons is the capacity of the bed when it is filled?—When it is filled.

15299. (*Colonel Harding.*) The water capacity?—The water capacity is reduced after working to 29 gallons.

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15300. Working all the time with septic tank effluent?—Yes.

15301. (*General Carey.*) You have lost one-half really?—We have lost two-thirds.

15302. (*Chairman.*) How long can you say in the whole of the two years; I mean since you have got to that fixed position which you have got, no further loss of capacity; how long is that in the oldest case?—Well, sir, in the oldest case it gets down to about a little over 20 gallons, but in that case there was no grading. The clinker was put in without any screening or selection whatever, and simply tipped into the bed.

15303. But in your more recent ones, where you have grading?—We find that we can maintain 29 gallons.

15304. And during the last twelve months you have found no difficulty?—No.

15305. Treating the beds as you think they ought to be treated, you get no choking up at all?—No, no further choking.

15306. Quite so, beyond that——?

15307. (*Dr. Russell.*) I see that in this report, dated 23rd April, 1901, you say that the capacity of a primary bed when first constructed is about 88 gallons per cubic yard, but that at the end of two years it was reduced to about 40 gallons per cubic yard. Has this very serious reduction to 29 gallons taken place since that date?—I think that figure of 40 gallons requires amending somewhat. The first bed, the No. 18 bed, which was the oldest bed, we considered could not be taken as a fair sample on account of the grading, and on account of other things. The sewage was turned on without being properly distributed by means of troughs, and in the other beds at that time, the more recently constructed beds, we found that we could get 40 gallons, but there has been a further reduction in those beds since that report was made.

15308. What is the date of this report?—(*Mr. Ross.*) 1901.

15308*. (*Chairman.*) But the diminution is not continuing?—(*Mr. Pickles.*) No, sir. Of course we have tested those beds that have filled up, and we find that by giving them a certain amount of rest the capacity can be increased, but at the same time it has not been found to last very long. It comes down rapidly to the 29 gallons.

15309. You feel confident that you are able to keep your whole establishment at that point?—Well, I think when we get an increased area, by giving the beds more rest, we shall be able to get an average above that.

15310. You are not proposing to increase your beds?—Yes.

15311. To what extent?—To 20 acres. That is, including first and second contact.

15312. And with that increase, you think that you will be able to treat the whole of the sewage that is discharged at Duckpits?—With the exception of the storm water, which will be discharged to land filtration, 20 acres of which will be kept for the purpose.

15313. You are making provision for that?—We are making provision for that. That is included in our scheme, which is at present before the Local Government Board.

15314. (*Dr. Russell.*) There is a reduction in your secondary beds also?—Those were the two beds, 22 and 23, on which the first experiments were based, and the material was put in far too fine, and we think the beds have consolidated. In fact, when we constructed the first and second contact beds we thought we could not get material fine enough. Now we find that is a mistake, and we find that the clogging is partly due to that.

15315. I think you said that the trade effluent in this Duckpits section was trifling?—Yes.

15316. I see you refer to two dye works and a tannery, which have been discharged into sewers by agreement?—Yes.

15317. Were there any conditions attached to that agreement?——

15318. (*Chairman.*) He stated that they demand a uniform flow into the settling tanks at the works?—Yes, sir. I might say that in the evidence I have given, I have confined it strictly to the Duckpits watershed. In the other watershed we have one particular works which can discharge a maximum of 100,000 gallons per day, but that does not affect this particular watershed.

15319. It is Duckpits we are going to visit to-day; Duckpits only?—Yes.

15320. (*Colonel Harding.*) I did not gather, probably you did give it, but I was not listening; what is the normal flow which goes to the works you have been speaking of?—2,000,000 gallons dry weather flow.

15321. And are you dealing with the whole of it on these bacteria beds?—No; we are dealing with, practically, about three-quarters now—about three-quarters of the ordinary flow.

15322. How is the remaining quarter dealt with?—It is dealt with on land.

15323. (*Chairman.*) You are keeping your old system for the one-quarter, which you have not yet turned over to the new system?—Yes.

15324. With precipitation?—The whole of the sewage is treated by open septic tanks.

15325. The whole of the sewage goes into open septic tanks, and three-quarters of that goes into contact beds?—Yes.

15326. (*Colonel Harding.*) Then the quantity you are able to deal with in the contact beds is 150,000 gallons per acre?—I think it comes out at 146,000.

15327. I have taken it roughly at 150,000?—That is per filling.

15328. Then we must multiply that by two?—One filling at 29 gallons per square yard gives 140,360 gallons. When the sewage is very diluted we work with three fillings.

15329. Shall I be right in taking it that in normal conditions you pass two fillings at the rate of 300,000 gallons per 24 hours?—Practically that.

15330. And that is increased to 450,000, or even more, in times of dilution?—Yes.

15331. And you think, from your experience, that you can continuously deal with 300,000 gallons per acre on these beds?—Yes, we think there will be no difficulty in that.

15332. The area includes, as I understand, in this calculation both beds. It is the total area of the coarse and fine beds?—I have given you the capacities of the coarse beds, because we find that we want a larger area of the coarser beds for first contact than for the second. I find that the filling takes place more in the first than in the second.

15333. But we are anxious to find out what, from your considerable experience here, you find may be dealt with on a given area of bacteria beds, and taking together the coarse and the fine beds, am I right in understanding that you can pass upon one acre, coarse and fine, 300,000 gallons?—Yes.

15334. And how long has this capacity been maintained that you have told us you have reached?—The 29 gallons?

15335. Yes. You have had a considerable reduction of capacity, and you are satisfied now that that capacity will be maintained if you do not go more than two fillings a day under normal conditions?—Of course the first bed, as I said, was constructed in 1898, and then we had two other beds in 1899.

15336. How long can you maintain this capacity of 29 gallons?—I think at the end of from two to two and a-half years this capacity is reached and can be maintained.

15337. From your experience, you gather that there is very little doubt that you will be able to maintain that capacity putting upon it the septic effluent?—Yes.

15338. Can you give any idea, it is rather material, what the cost per acre of your bacteria beds has been?—Yes; of course all our beds having been laid out and terraced for land filtration, we had very little excavation to do, and on page 18 of the report you will find a table, sir, giving the actual cost per square yard, worked out per square yard, and you will notice there, sir, that the amount put down for the excavation is very slight indeed, because there was very little to do. So that the cost of the beds will vary according to the cost of excavation. But we took it, and we found that our beds worked out at £1,200. In the other beds we shall probably have more excavation, and we put that

down at £1,400, and we think that will more than cover it.

15339. (*Chairman.*) The new beds you propose?—Yes.

15340. (*Colonel Harding.*) £1,400 per acre?—Yes.

15341. But in your case the levels permit of your doing this with very little excavation?—Very little excavation. In fact, in most of the beds that have been constructed, we simply had to skim the bottom, so as to get a proper fall for the drains, and we used that excavated earth for, perhaps, raising the banks so as to get the filter fully 3ft. deep, and that was exactly all we had to do.

15342. Then I only want to ask you about the septic tanks. I understand you are proposing to extend the area?—Yes.

15343. Why?—We are proposing to double the capacity.

15344. Is it because you find too many suspended solids come through?—That is so.

15345. What is the amount of the suspended solids?—(*Mr. Ross.*) About 13 parts per 100,000.

15346. And you think that by doubling the area, or increasing the area, you will reduce that?—(*Mr. Pickles.*) Yes, sir, we do. At present our solids are intercepted by the distributing troughs of the beds, and can be cleaned out.

15347. A good many of these solids do not reach the beds?—Of course some must, but a lot of the solids are intercepted in these troughs.

15348. And your idea in extending the septic tanks is to reduce the settlement in these troughs, and to reduce generally the solids put on the beds?—Yes, and also, we think, that a larger quantity of sludge can be disposed of in the septic tanks; in other words, that we shall be able to work a longer period without sludging. At present we empty the tanks every four months, three times per year. Each time, of course, the tanks are pretty well full of sludge when they are emptied.

15349. I understand your idea in desiring to extend the tanks is to obtain a larger consumption, or change or dissolution of the sludge, also to have a clearer effluent?—Yes.

15340*. Have you tried any small experiment with septic tanks to see whether you get a clearer effluent by a longer stay in the tank. You have not tried on a small scale?—With the exception of the first experiment, where the tank was filled once every 12 hours, and the tank adjoining every 24 hours, and the one was working at double the rate of the other. That is the only experiment.

15341*. And what was the result of it?—(*Mr. Ross.*) There was very little difference between the two. The solids were uniformly slightly less, and the analyses, you may say, are so equal as to give nothing worth bothering about. The suspended solids were very slightly less, about two or three parts per 100,000 less.

15342*. That was rather against the proposal to extend?—It was rather against, but that was running only a given quantity of sewage through the tanks in a given time, whereas working our tank in the ordinary way, we have to turn the whole of the sewage through, and so we have a big flow coming through, and at present in wet weather it will only stay about four hours in the tank, and that does not give it a chance of settling in any way. We must have at least eight hours for the sewage to stay, putting aside all septic action altogether, so as to give it a fair chance. In this other experiment one having 12 and the other 24 hours, it only meant the difference in the septic action; the amount of the settling was equal in both cases. (*Mr. Pickles.*) Of course, with our arrangement of tanks, in emptying the tank for sludge purposes we run the top water off into the sump, and then pump from that into the inlet channel again, and then run the whole of the sludge into the sump, so that the tank is completely emptied.

15343*. Are your fine beds sufficiently fine to keep back suspended matter on the surface?—No.

15344*. It is such suspended matter as goes into the bed, works its way down into the body of the bed?—I will not say down to the bottom, but it keeps working.

(*Chairman.*) We shall have the analysis of the effluent from the chemist.

15345*. (*Mr. Stafford.*) You have got a separate system of drainage for the surface water?—Yes.

15346*. And that doubtless accounts for the absence of grit in the works. There is a comparative absence of grit in the works?—I do not think we have the average quantity of grit. You see all our streets are practically paved. We have very little macadam road.

15347*. There is a statement on page 15 of the report of 1891 that "the microbes in the beds, besides purifying the sewage in the manner already described, act as destroyers of pathogenic organisms, and finally encompass to a great extent their own destruction." Have you any scientific evidence as to that?—(*Mr. Ross.*) We have no scientific evidence of our own. The only thing this is based on would be the Massachusetts report.

15348*. But you have not investigated the matter?—No, I have not.

(*Chairman.*) We will have the chemist and ask him directly.

(*General Carey.*) Do you work the contact beds in cycles of eight hours? I understand there are three fillings in 24 hours?—(*Mr. Pickles.*) When the sewage, of course, is strong, two fillings.

15349*. The ordinary rate is two filling in 24 hours?—Yes.

15350. Is the first eight hour cycle, one hour filling, and two hours' rest in the filter and one hour entering. Is that how you work the beds?—(*Mr. Ross.*) We have two hours filling, two hours rest when full, and three hours to empty.

15351. You do not take two hours to fill it?—It varies. It will take an hour; then it gets three hours before it is filled again under any circumstances. Some of the beds take longer to fill, and the manager simply has to work his cycle so that no bed has less than five hours between first being filled and its finishing being empty.

15352. At the end of five hours you start again with that bed?—We start again.

15353. Then it has 10 hours, has it, of complete rest in the 24 hours?—Yes, and the valve is left open for it to drain as much as possible, because they will drain for a long time slightly.

15354. And about the sludge from the septic tanks. How do you dispose of it?—It is all pressed and sold to the farmers about, and as there is no lime in the land around this district, and this sludge has to have lime added to it for pressing purposes, it suits them very well as manure.

15355. What do you get for it?—10d. a ton.

15356. (*Chairman.*) That is the lime value?—There is no other value in it.

15357. (*Colonel Harding.*) What amount do you add to the sludge?—It works out at about 18 per cent. of dried sludge. It is about 18 parts of the dried sludge.

15358. Then, you do really, in order to neutralise that sewage, add a considerable quantity of lime?—No; that goes in quite separately.

15359. It is only half a grain per gallon?—Even less than that.

15360. What you add for pressing purposes to the sludge is considerable?—Yes, it is a very considerable amount. (*Mr. Pickles.*) Of course, lime is added to the sludge for the purpose of pressing. We could not get a solid cake if there was not lime added, and we find we have to use more lime to make the septic sludge press than the other. Of course, we were using a large quantity of lime for precipitation purposes, and, of course, a lot of that would help the sludge to press.

15361. Did you find the septic tank solid specially offensive?—No; I do not think it is specially offensive, sir, but it is more difficult to press.

15362. Sludge from rapid settlement?—No, precipitated sludge. It requires more lime, of course.

15363. (*General Carey.*) And no nuisance is created when you put the septic tank effluent on to the land?—No.

15364. None?—There is no nuisance to the surrounding property, but the land beds are in very bad condition, sewage sick, and we find there is practically no filtration. We have had no complaints from the adjoining owners.

15365. I suppose you can detect a nuisance?—Oh, we think that the land is in a dreadful state owing to the accumulation of sewage in it.

15366. But when it is first put on the land from the septic tank is a nuisance created? Can you smell the nuisance from the effluent?—No, we do not. Of course, you can always smell it in sewage works; but there is

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nothing particularly offensive, nothing more than you would expect from an ordinary tank effluent. It is when the beds become clogged, when the land areas become clogged, that nuisance arises.

15366*. (*Dr. Russell.*) Is it worse than the effluent from the precipitation process?—(*Mr. Ross.*) In hot weather, but not at ordinary times.

15367. (*General Carey.*) Is the land you are now using so sewage sick that it will not deal with the septic effluent, or even a quarter of the whole?—Well, when we get surface clogged then, of course, there is very little filtration, but we find that the quantity that is dealt with by the land is exceedingly small in proportion to the total.

15368. (*Colonel Harding.*) What is the nature of the land?—It is gravel at the river where the areas are that we use for this land filtration. Of course, when it gets higher up, where the beds are, we find clay, stiff loam and clay.

15369. Does this become impervious because of the coating on the surface? You say it will not take the sewage?—Yes.

15370. Is that because of what is deposited on the surface?—Because of what is deposited on the surface.

15371. Cannot you turn that over and plough it in?—Yes.

15372. Nevertheless, it is offensive?—Yes; we plough the beds, crop them regularly. We take a new bed that has been dried and ploughed and harrowed, and we turn the tank effluent on to it. It does not work long before the surface becomes clogged.

15373. Are we to gather from what you have just now told us that you think it is more easy to maintain in efficient working order an artificial area such as your bacteria beds, than a natural area of land, such as that you are using for part of your sewage?—Yes.

15374. You have formed that opinion?—Undoubtedly.

15375. You have no doubt about it?—No doubt about it.

15376. (*Chairman.*) Your new action is based on that view?—Yes.

15377. (*General Carey.*) Assuming that your area of land is not large enough?—No, sir, it is not.

15378. Then your land is overtaxed by the sewage that you have been putting on to it?—(*Mr. Pickles.*) Well, it was not exactly overtaxed, because we simply let the land treat what it could efficiently, and the remainder was discharged into the stream direct. You see, when we had the whole 40 acres nett filtration area, we simply turned all the sewage the land could deal with on to the land beds, and the remainder went——.

15379. Went into the river; but apparently the land could not deal with this quantity of sewage?—Could not deal with it.

15380. Why, if there was not more than sufficient volume, was not the land able to deal with it? Is it because of the insufficient quantity of the land?—There was not sufficient.

15381. But I thought you said before you put on to the land the amount of sewage suitable for that particular area of land you had available, and the rest went into the river?—Yes, but I understood you to refer to the dry weather flow, the 2,000,000 gallons dry weather flow.

15382. I do not know how long you have been doing this, but you have been putting in a certain proportion of the sewage on to the land as septic effluent. You are doing it now?—Yes.

15383. Is that land capable of dealing with the septic effluent in that proportion, or is it incapable from its condition?—Well, it soon becomes incapable. It is capable at first.

15384. From the condition of the land?—From the condition of the surface.

15385. Yes, from the condition of the surface, but not from the quality of the land?—The quality of the land we think is very good.

15386. Then the land really has been ruined, I may say, by your putting the whole of your sewage on to it, the 2,000,000 gallons or whatever it was in the first place?—No, the whole of the sewage has never been put on the land which has been laid out.

15387. Then, why has the land failed to deal with it if the land has never been overtaxed and its quality is suitable—why has it been made sewage sick, or why is it incapable of dealing with a fair proportion?—The land was not made sewage sick. The reason for changing our scheme was the fact that the land would only treat a very limited quantity per acre.

15388. And that limited quantity you have been putting on to it?—Yes, and the land effluents were very efficient. I think I stated that.

15389. I do not quite understand now. You said this septic effluent, or a portion, one quarter of the whole, is being put on to the land?—Well, at the time, sir, when I mentioned the matter I was referring to the effluent from the precipitation tanks. You see, roughly, 40 acres in the filtration area were laid out as land areas, and we let that land treat as much as it could efficiently. The rest was discharged into the river direct. We found that that area of land would only deal with one-fourth of our dry weather flow, and we never attempted to make it deal with more, but the effluent that we got from those beds while it was dealing with that fourth was fairly satisfactory. It meant that we should have had to get four times the area of land in order to deal with the whole dry weather flow.

15390. I understand now?—Or put down some other scheme, and we considered the question of getting additional land.

15391. But you have got the whole of this area of land now, and you are putting one-fourth of the sewage on to it from the septic effluent?—Yes.

15392. One-fourth. Is not the land capable of properly dealing with that effluent?—Of course, we think that one-fourth is too large a volume for the area.

15393. The one-fourth is too large a proportion?—Yes, in the present condition of the tank effluent.

(*Colonel Harding.*) What does one-fourth represent per acre or per square yard on the land? What I want to know is at what rate are you working the land now?

(*Mr. Ross.*) Any rate, really. That is what it comes to now. It simply comes to this: Supposing it is wet weather, everything that runs down comes down over the land, and what will not go through will go over.

15394. The land is being evidently overworked?—Put it in this way, that the land was not worth bothering our heads any more about. We had only to satisfy the Board of the Ribble Joint Committee, and the question was, how could we best satisfy them. "Will it please you better if we run the whole lot over the land?" They said, "Yes; you can run the whole lot over the land." We do not care that about it, because we should have to buy an enormous quantity of land to deal with our flow during anything like wet weather, and to deal with it efficiently, and therefore we placed our whole reliance on the beds. We are working for the beds, and for the last year or so we have not bothered much about filtration areas, but have done it simply as a matter of satisfying the Ribble Joint Committee.

15395. It comes to this: you recognise you can overwork the artificial areas of the bacteria beds just as much as you can overwork the land, and that you are only turning to your bacteria beds because you find the land not available in sufficient quantities, and therefore you must have artificial areas of special construction?—It is a mere matter of expense, and, looing at the whole sewage scheme from an economical point of view, we have come to the conclusion that we must expend a good sum of money in laying out an area where we can treat a far larger quantity of sewage for the same sum of money expended and get an equally good result. (*Mr. Pickles.*) I find it works out to about 25,000 gallons per acre.

15396. That is large, especially as it is partly clay—enormous?——

15396*. (*Chairman.*) The Borough Analyst has satisfied you, then, as to the condition of the land. You gave me, Mr. Pickles, the population of the whole of Burnley. What is the population of that part of Burnley whose sewage is dealt with?—(*Mr. Pickles.*) 80,000 in the Duckpits area. That gives 25 gallons per head practically over the whole. The water supply is 22·9 gallons per head per day. The difference is due to the fact that a great deal of water is drawn from the canal for use with the condensing engines, and instead of being returned to the canal, as we think it should be, a small proportion finds its way into the sewers, and to some other minor matters.

(*The Commission proceeded to view the Sewage Works.*)

FIFTY-THIRD DAY.

Friday, 24th October, 1902.

SALFORD.

PRESENT:

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P. (*Chairman*).

Major-General CONSTANTINE PHIPPS CAREY, C.B., R.E.
Colonel T. W. HARDING, J.P.
Dr. JAMES BURN RUSSELL.
Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary*.

ALSO PRESENT—

Dr A. C. HOUSTON.
Mr. COLIN C. FRYE.

MINUTES OF EVIDENCE taken at Salford Sewage Works, on the occasion of the visit of the Commissioners.

Mr. J. CORBETT, Engineer of the Salford Sewage Works, called; and Examined.

Mr. J. Corbett.
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15397. (*Chairman.*) Your titles, if you have any?—I have none, sir.

15398. You are in charge of these sewage works?—In charge of the sewage works. I have designed the scheme partly.

15399. You are treating the sewage of the whole of Salford?—Yes.

15400. A population of?—About 233,000. The present estimate of the works was a little in anticipation, say for a quarter of a million at any rate.

15401. Your present dry weather flow is?—Just within 8,000,000 gallons.

15402. Can you briefly state the history of the works?—The works were first established and formally opened in July, 1883, having cost for land and structural works £103,000.

15403. That was the beginning, was it?—That was the beginning of these works. The intercepting sewer system had been chiefly constructed before that date, partly with a view to the works, and also for the purpose of draining low lying districts that were subject to flood, or to the backing up of their sewers from small freshets in the river. The intercepting sewer crosses under the river again and again, and is at a low level through the whole borough, and therefore brings a great deal of land water. It was partly intended to do so. Then where the intercepting sewer arrives at the bottom part of the works, the southern part of the works near the river, and at the river level—now the Ship Canal—with a surface level 3 ft. above the former navigable river level, so that one might say the culvert is on a level to discharge into the Ship Canal, and we have pumping engines to pump the flow from the main intercepting sewer to a height of about 30 ft., and at the higher level it is joined by a flow equal to about one-sixth of the whole from the gravitation sewer. Then the whole stream flows into the chemical precipitation tanks. In its course to the tanks it first passes into a mixing chamber.

15404. You are now describing the process as established in 1883?—Oh, no, sir.

15405. Can you tell us what you did in 1883?—Yes; I can tell you how it was then. In 1883 the pumped sewage and the gravitation sewage were kept separate until the moment of their entering the tanks; and at that time they entered the tanks at the west end—the distant end—and there were long lines of pipes from the end where it was pumped to that end, and the lime process was adopted, and the lime was supplied separately to the two flows of sewage. There were considerable difficulties in equalising the proper discharge of lime, and a number of experiments were tried with a view to improving the arrangement, and we gradually, step by step, altered and improved.

15406. In 1883 you received your sewage into tanks and added lime?—And added lime.

15407. The quantity of lime added being different in the case of the two sources?—It could be varied. I do not think we have methodically varied it, but there were variations made and various experiments tried from time to time.

15408. At that time were you taking the whole of the sewage?—The whole, so far as it was intercepted, but the intercepting system was not quite complete, and was being completed to various parts, so that it would not be at the very first more than three-quarters of the whole flow, and gradually the interception was quite completed.

15409. And that was in the main domestic sewage, or to a very large extent trade refuse?—No; as nearly as we can estimate, of that 8,000,000 gallons something like 5,000,000 gallons was domestic sewage.

15410. That is at the present moment?—Yes, would be 7,000,000 gallons twenty years ago. The dry weather flow was estimated at 7,000,000 gallons.

15411. The proportion of trade refuse remains about the same?—It will be greatly increased by the extension of the works. We have some of the largest dye works and iron works in England.

15412. You had in 1883 a considerable quantity of trade refuse. That has been largely increased out of proportion to the domestic sewage since 1883?—I have not the means of doing more than just roughly estimating, but I think that the trade refuse has increased quite as rapidly as the population, which has also greatly increased.

15413. And that trade refuse is to a large extent from dye works?—Dye works, print works, iron works, breweries.

15414. Are the iron works a large proportion?—We have a number of large machine shops, very large machine-making works.

15415. Making a great deal of acid waste?—A great deal sometimes, but usually our sewage arrives nearly neutral, sometimes we have a considerable quantity.

15416. Tanneries?—We have a few tanneries, not large, and some large breweries.

15417–18. The dye works and the cotton works really represent the greater part of the trade refuse you have to deal with?—Both the dye and printing works are very large, and they have deep wells from which they pump water which they deliver into the sewers. The town's water delivered to the borough is probably something over 5,000,000 gallons a day, as near as we can tell. We are supplied from the Manchester Water Works, and I have not a correct record of the whole, but it is something over 5,000,000 gallons. It is the town's water of which perhaps two-thirds is domestic and one-third trade, and of the remaining 3,000,000 gallons probably 1,000,000 is pumped by the various works and added to their works output, and 2,000,000 gallons or so is land water from the land drainage.

15419. Then in 1883, having received the sewage into the tanks and treated it with lime, after settling, what became of the effluent?—The effluent ran directly to the river after lime precipitation.

Mr. J. Corbett.

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15420. Nothing else at that time?—Nothing else at that time.

15421. But what did you do with the sludge?—The sludge we kept on the premises, and that was one of the great difficulties. We had no means of disposing of the sludge; we never adopted sludge pressing. We gradually stored in the waste area in the site an enormous quantity, until at the time we began to remove it, six or seven years ago, after the opening of the Ship Canal, we had about 160,000 tons of dried sludge on the ground. Some of it, of course, was ten or fifteen years old, and so had hardened to a density of fully 40 per cent. The average density, as we ascertained it, was a little under 40 per cent. of total solids.

15422. Will you briefly state what changes you have made since 1883?—Let me describe what the tanks were in 1883. In 1883 we had 12 tanks of a capacity of about 5,250,000 gallons. That was the total capacity. We have now altered those tanks. Of the dozen tanks which are in two rows of six, we have taken two tanks to make into roughing filters, that is mere strainers of fine gravel, and of the remaining tanks we have made each set of five into one long tank by cutting down the cross walls to about half their original height, so that the cross walls are now about 3 ft. or 4 ft. high, and there is a water depth of nearly 8 ft. average, and so it is two long tanks each about 80 ft. wide and 600 ft. long, and we generally use the two together as far as practicable, but for removing the sludge we at present have only the old-fashioned way of lowering the water, and pushing out the sludge with push-boards into outlet sluices, from whence it goes into a subway under the central channel, and there the men can aid it along in an open channel, and it goes to secondary precipitation tanks or sludge tanks from whence it is pumped into our steamer to go to sea.

15423. What is the capacity, then, of these two large tanks?—Two have now a capacity of 4,750,000 gallons. We have raised the water level a little from what it was, and in that way we have partly compensated for taking a certain area away, so that we have now a total tank capacity of 4,750,000 gallons.

15424. So that the daily flow from the tanks amounts to?—It is more than 12 hours, it is 4,750,000; and as 8,000,000 gallons is the dry weather flow, we have fully half of this dry weather flow capacity, and, at present, in the system we follow we have chemical precipitation. which is now being done with lime and copperas in very moderate quantities.

15425. What proportion, about?—I think it is about four grains to the gallon of lime and four grains to the gallon of copperas.

15426. When did you begin to add the copperas? Did you begin with lime only?—We have experimented with over 30 processes; we have been experimenting now for 13 years with various chemical processes, patent combinations, and also known combinations of known salts, and we have completely threshed out the question of chemical precipitation and we have come to the conclusion that the cheapest and most effective process we have yet tried is lime and some salt of iron. There are various salts which show about equal results. Mr. Carter Bell, the analyst, can tell more particularly than I can as to these differences, but that is the broad result.

15427. And that has been adopted since with lime and copperas?—Lime and copperas have been used time and again.

15428. Then when did you finally adopt it as your permanent system?—Well, in March last we started the complete use of our works with filters. I have here a diagram showing the whole analyses from March last.

15429. Could you briefly describe your system as it now is?—The sewage is arriving at the east end of the tanks now, not at the west end as formerly. The sewage arrives at a mixing chamber, that is an iron tank about 10 ft. square with a number of valves in and out of it controlling the different channels, and with a vertical shaft revolving in it with blades like a screw propeller, 6 ft. in diameter, and thoroughly mixing the sewage with the lime. The lime is there added as milk of lime.

15430. I thought you had first two brick chambers or something of that kind in which you received your sewage?—We have strainers before it goes into the pumps. Perhaps I should have mentioned that. In the main sewer we have a series of gratings. We have not a permanent grit chamber before reaching the pumps. We have a series of screens through which the sewage passes on its way to the pumps, and then, passing from the pumps, it goes directly to this mixing chamber, and after the mixing chamber and the application of the lime comes the grit or silt pit, and we have there a silt pit 100 ft. long by 10 ft. wide and about 12 ft. in depth, and another silt pit after that of half that length of the same section.

15431. The two in series?—The two in series. It is really that we had a long channel, 10 ft. wide, and deepened it down into a silt pit for a length of 150 ft. Then we get into that silt pit the heaviest deposit, and that is discharged through an 18-in. pipe to our sludge tanks, to be, if necessary, further precipitated before sending on our steamer. And the main flow of sewage goes along a central channel between the two great tanks to the west end of the tanks, and there, at present, copperas is added by temporary means. We shall eventually have good machinery for the purpose, but at present we are using temporary hand labour appliances for applying copperas at some 600 ft. distance of flow from the point where the lime is applied and immediately before the sewage enters the precipitation tanks. Then the sewage enters the tanks through the barrier walls, that is the wall from the floor of the tank up to above the surface, with all the lower part of it pierced with alternate pier and opening, pier and opening all along, so as to completely break the flow and let the water come quietly into the tank without any current, and that it very effectually does, and the precipitation goes on through the 600 ft of tank with the dwarf walls, and we have four skimming boards in the length of the tanks, and at the east end of the tanks it reaches a cross channel, simply a connecting channel for connecting the tanks and the various filters, and in the site formerly occupied by two of the dozen tanks we have now six roughing filters, as I have called them, that is gravel, about a yard depth of fine gravel, and the sewage after precipitation is passed through this fine gravel in order to intercept any fragments, bits of string, or bits of wood, or anything else that might tend to choke our final filters. From thence it goes through a series of valves, so arranged that we can reverse current and have upward washing in the gravel, and goes forward to the final filters, what are now called bacteria beds—we called them aerating filters when the scheme was brought forward. This scheme was put before the committee just 8½ years ago to-day, to the day in fact, and so it was designed completely before the modern septic system or the term bacteria bed was in use. We called them aerating filters when we began with them, but to adopt the term now ordinarily in use they are bacteria beds. These bacteria beds are a very special feature, just as the gravel bed probably is, seeing that they are open beds for what is now called the trickling system; not holding up and letting go, what has been called the Dibdin system, but trickling through. I, in fact, based this scheme on the Massachusetts experiments, which are all on the trickling flow system.

15432. What is the area of these aerating beds?—26,000 sq. yds., the aerating beds.

15433. What is the area of your roughing tanks?—2,040 sq. yds., so that it is a very rapid flow through the gravel, simply a straining action.

15434. Then the effluent from the gravel is distributed by a special mechanism over these large aerating beds?—Yes, and you will see that, and that is why we have fixed sprinkler jets and not the moving sprinklers that are used in many cases.

15435. We shall see these in operation?—Yes, you will see these, and they will be better than Whittaker's. They sprinkle the whole area of these aerating filters.

15436. What is the depth of these filters?—There is 5 ft. depth of material now, but we are proceeding to fill them to a depth of 8 ft.

15437. Then what is the material of which they are constructed?—Cinders, such as come from destructors and all boiler furnaces.

15438. Of varying dimensions?—Of a size that will pass between holes of three-sixteenths of an inch and three-quarters of an inch diameter.

15439. Selected?—It is all screened in revolving screens with round holes of that size. Then the floors of these several filters are covered with tiles on short legs, forming a sort of false floor, with a complete open air space underneath giving a free vent for the water and also for the spent air from the filter. Our intention is that the

air and the water should go down together, the air to escape freely with the water by the open floor into large culverts which are provided, and which have frequent manholes for blowing off the air. And we have tested everything by years of experiment and have made little model filters, some of which you can see still existing, and we have ascertained that with a good chemical tank effluent—which is the first essential—with a good chemical tank effluent we can use these filters night and day without intermission for very long periods.

15440. Do you use the whole of your aerating filters at once?—We could do if we required them, but the jets are intended to discharge 1,000 gallons per square yard when flowing 24 hours per day; that would give a discharge of 26,000,000 gallons per day, more than three times our dry weather flow, so that in dry weather we need only run each of our filters one-third of the 24 hours.

15441. But the material is distributed over the whole of the surface, though at a lower rate in dry weather?—No, we should flow at the full rate and intermit from filter to filter. We have 15 bays in the filter, each controlled by a separate valve, and so in dry weather we can run five or eight bays for five or eight hours, giving them a 16 hours rest in the 24. Then as the rainfall increases the flow, we can increase their daily duty from 8 hours to 12 hours until it gets to 24 hours flow, when we should be pumping more than three times our dry weather flow.

15442. That system now has been going on?—Since March. We have a diagram showing the result.

15443. We will ask the analyst that. During this time have you made any change in these beds at all?—We have simply been filling them up. The first bed began action in March. We went on filling. There is the record of the first bed which was at work all that time. Some other beds have only worked for two months, as they have been filled up.

15444. Is there any sign of choking in any of those beds?—There is a little surface choking in the first bed.

15445. The oldest one?—The oldest one, but that I attribute to the works not being thoroughly complete. It is part of the scheme of the works that the precipitation tanks shall be used, not by filling and emptying for the purpose of removing the sludge, but kept constantly running, the sludge being removed by special machinery while the tanks are in use. That is one point that will give better precipitation. Then, again, machinery is designed for cleaning the gravel of the roughing filters, by dredging it up and washing it in a machine similar to a sand washing machine at a water works and putting it back again. Those machines we have not yet, therefore the works are working at a disadvantage. It is not yet a complete scheme.

15446. Then the effluent from these aerating beds is discharged?—Directly into the Ship Canal.

15447. Then can you make any statement as to the cost?—Yes, I have figures here as to the cost of it, and I may just mention, incidentally, that we have a steamer which cost £12,000 and the tanks for it £3,000. The cost of the recent works when fully completed, that is including the machinery I have mentioned, will amount to about £80,000, so the whole cost from first to last, the original works, the alterations, the steamer, and the new works, will amount to about £198,000 to serve a population of, say, a quarter of a million, or 16s. per head.

15448. That is the outlay?—The total outlay from first to last.

15449. And what is the cost of the working?—That we cannot say with certainty.

15450. Have you any rough idea?—No, I cannot state very much as to that. I believe that the cost of working will be a very slight increase on the cost of working originally with the lime process, because we are using very much less chemicals.

15451. What was your cost for working expenditure at that time?—I cannot give you the figure offhand, I could give it to you from the books, but the labour would be very much as before, when the works are complete, and the chemicals are now a small quantity compared with what we used in the lime process.

(*Chairman.*) That is, I think, all I have to ask you.

15452–53. (*Colonel Harding.*) You realise that it is a great advantage to bring upon your trickling filters nothing but a thoroughly clarified effluent?—Yes, I think that is essential for the high speed at which we are working.

15454. And you find the action of the trickling filters upon dissolved impurities to be effective and rapid?—Most thoroughly effective. We have used these filters now for just about ten years experimentally, and our results have always been very good.

15455. Then what is the time taken by the effluent in passing through the trickling filter?—I can only estimate it by the first flow through, and perhaps the later flow is somewhat slower when the filter is charged.

15456. You have not made any experiments for ascertaining?—We have observed that when putting the water freshly on to the filter we frequently get the filtrate out in twenty minutes, but perhaps with a deeper filter it might exceed twenty minutes.

15457. You have not tried the experiment of putting in colouring matter at the inflow and seeing how rapidly it reaches the outflow?—No, we have only ascertained the time of commencing work, and how long the dribble lasts.

15458. You have, doubtless, the analysis of the effluent as it goes on to the filters?—Yes. The chart here shows the original sewage, the tank effluent, the roughing filter effluent, and the final effluent.

15459. I will only ask you with regard to the first process. You still use these chemicals, and you find it necessary in order to get adequate precipitation to have your precipitation assisted by chemicals?—Yes, we have tried just for a few days without chemicals, but it was quite ineffective for our purpose.

15460. The settlement was insufficient?—Yes.

15461. Then you have made no experiments at all in what is known as septic treatment?—No, we have never touched the septic process.

15462. Because your 12 hours' rest, if it were unassisted by chemicals, would enable you to test the septic action?—It would be possible. I have carefully studied what has been done, especially at Manchester, and I have formed the opinion that to introduce the modern septic system we should have to make such enlargements, such heavy capital expenditure, as would outweigh any possible advantage.

15463. You can get a 12 hours' stay in your present tanks?—That we do have in effect. No doubt there is considerable septic action in the sewers before it gets here. We have very large sewers with a moderate fall.

15464. Have you ever tried any experiments in tanks where the effluent is allowed to remain several hours undisturbed, stagnant settlement?—We have tried it to some extent in our tanks, and we have tried also a number of experiments by isolating the separate tanks when we had 12 tanks. We isolated individual tanks. Instead of allowing the sewage to flow through a series of tanks, we worked with two in series and with one tank singly, each dealing with a proportionate amount of sewage, and we found that the results were not quite so good as by the through flow, and it was a much more troublesome process to work, so we returned to the through flow system.

15465. Do you remember the average suspended solids in your effluent as it leaves the tanks?—I could not give you that, no doubt the analyst can give you that.

15466. (*General Carey.*) You claim to purify the sewage of a quarter of a million of people on 5½ acres of beds, after precipitation in tanks. It is a remarkable result, but you attribute it principally to efficient precipitation in the tanks?—The efficient precipitation is a first essential. That gets rid of about half of the pollution, according to the analysis. Then the protection of the bacteria beds by the roughing filters, I think, is very important, as it prevents that silting of the surface which sometimes occurs. No doubt the spray jet is of itself a certain advantage in aeration. Owing to the evenness of distribution over the surface, it is impossible for a hole in the bed to take the current for instance, but spraying it on leaves each particle to do its work, and the ground cannot be overworked.

15467. What proportion of trade refuse do you take into your sewers? What is the volume of it?—I have no accurate account of that, but I estimate that in dry weather the trade refuse is between 1,000,000 and 2,000,000 gallons out of 8,000,000 gallons.

15468. Have you any means of regulating the flow into the sewers?—No, we have no control at the works. I may just mention that we encourage the owners of works to put down precipitation tanks wherever they are liable to discharge solids into the sewers, and we take away the sludge from them and treat it; we cart it

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from their works, bring it here, and simply mix it with our sludge and dispose of it.

15469. You receive the volume of trade refuse in irregular quantities?—Quite irregularly.

15470. At any time of the day?—Yes, and the sewage varies in colour, and no doubt in quality, from hour to hour.

15471. How does that affect the difficulty of purification in the beds?—Generally, there is no perceptible effect. Just once in a while, once in a year or two, we have had some special disadvantage which has given us trouble, especially certain tarry discharges which we could not quite identify as to whence they came. They did trouble us for a day or two, but those are only what one may call momentary difficulties.

15472. In times of storm you are prepared to treble or more the volume of dry weather flow?—To treble the dry weather flow we are now prepared for; if more than that is asked for by the Irwell and Mersey Joint Committee we shall have to extend our filter beds, and we have the space ready.

15473. Have you actually tested the results of a storm?—Only this, that we are working day and night. We have a record kept of what is the rainfall day by day to compare with the daily results, and the rainfall shows very plainly in the sewage. The sewage comes more dilute after the first heavy fall and rinsing out of the sewers. Then, of course, we have a better effluent when we have better sewage to do with.

15474. (*Mr. Stafford.*) I understand you to say your area is sufficient to allow you to give each filter 16 hours rest out of the 24?—In dry weather, yes.

15475. And how do you know that you can use the filters continually without rapid choking?—We tried two experimental filters for a period of 12 months. The order was given to run them night and day continuously at a flow of 1,000 gallons per square yard. They were served by a steam engine, and the man had to stop the filters for half an hour or an hour just to clean up and oil his engines, but barring that and incidental stoppages for a few days, we ran these filters for 24 hours for 12 months with excellent results all through.

15476. You have never tried them with the new beds?—The new beds have not been so tried.

15477. You do not know whether the system would work so well on a large scale then?—I am confident it will because we did not experiment on a very small scale. You will see that the experimental beds are a fair size, and they represent a population of about 2,000 for our experimental purposes.

15478. You had no choking, working continuously?—We had no difficulty whatever in working continuously, and that was with the ordinary sewage, both dry weather and wet weather sewage, day by day as it came, and we were then having a very good chemical process, and so it was a very good tank effluent that the filters were dealing with.

15479. (*Dr. Russell.*) Is that the only interference with manufacturers, the inducement to lay down subsidence tanks?—That is the only interference we have made. We have made some inquiries at the works with a view to endeavouring to introduce some control, but as yet nothing has been systematized in the way of control.

15480. You mean the control of the amount?—Control of the discharges, requesting them, for instance, as has been done in Manchester, to run their flows through a number of hours, instead of suddenly discharging large quantities.

15481. Have you had any trouble at all in getting the manufacturers to accept these conditions?—I have not yet introduced the conditions; it is simply that it is contemplated, and Mr. Carter Bell and myself have visited some of the largest manufacturers to see their places and talk it over with them, with a view to presently introducing the system.

15482. (*Colonel Harding.*) With regard to the brass jet which has been shown us, is that a patent appliance or is it something of your own which has been introduced here?—It is made by a local man; there is no patent for it.

15483. It is a suggestion which has arisen from yourself or from your Committee, is it?—It was the man's own idea. We had a number of experimental jets made, and that is the latest development, and it is very successful.

15484. You gave us, I think, the flow through that jet?—I could give you the flow for the month through an individual jet. I did not state that, except that they are so arranged as to discharge 1,000 gallons in the 24 hours. Those jets are placed at distances of 10ft. by 5.

15485. Then if you want to modify the flow, do you do it by difference of pressure?—By hours, keeping the full flow and regulating the hours. We do not work eight hours on end, but we work at intervals. Of course, we have not to discharge at the exact interval, but we have the valves under ready control, and we have worked at two hours' rest and two hours' flow, and we have sometimes worked at one hour's rest and one hour's flow, and so on. All that is quite open to management.

15486. When you say 300 gallons per square yard is what your filters do, do you mean that they do that in eight hours?—In eight hours.

15487. So that if they were kept going for the 24 hours it would really represent 900 gallons?—The jets are intended to throw 1,000 gallons per square yard in the 24 hours.

15488. Then while the valves are run the flow from them is at the rate of 900 gallons per square yard per 24 hours?—1,000 gallons in the 24 hours is what we have aimed at, but I was going to mention this: the figure of 900 gallons, which you have mentioned, does coincide almost exactly with the results of what is the actual flow in the jets. I purposely made the jets at first a little small, thinking they would enlarge in use, and so at present they are throwing about 900 gallons in the 24 hours, whereas I intend them to throw 1,000 gallons in the 24 hours per square yard.

15489. That is not quite clear to me. I want to know at what rate the valves are working while they are working. I gather from this printed statement that you are passing 300 gallons through the filters in the 24 hours, I also gather that you are doing that in eight hours. Therefore, during the eight hours you are working the effluent is passing through the filters at the rate of 900 gallons the square yard?—Per day.

15490. In eight hours?—It comes to the same thing because you rest the remainder of the time, but whilst they are working they are run at the rate of 900 gallons per 24 hours.

15491. So that running only eight hours you average 300 gallons per square yard?—Yes, that is one-third.

(*Colonel Harding.*) I appreciate now

Mr. J. Corbett.

24 Oct. 1902.

PAPER subsequently supplied to the Commission by Mr. *Corbett*, the Borough Surveyor of Salford.

Manchester Corporation, Sewage Works, Urmston,
October 17th, 1902.

D ar Mr Corbett

HEREWITH I send you the figures of the Bacteriologic l Examination which I promised to give you.

Total number in 1 c.m.:—

Effluent from roughing filter - - -	10,000,000 (on gelatine.) 4,000,000 (on agar at 37° c.
Number of bacterium coli communis - - - -	10,000 per c.m.
Final filtrate, total numbers - -	1,350,000 (on gelatine. 720,000 (agar.) 5,000 coli communis.

Chemical Examination of Salford Sewage and Effluent, October 10th, 1902.

	Grains per Gallon.			
	Raw Sewage.	Tank Effluent.	Roughing Filter.	Filtrate.
Four hours oxygen absorbed - -	11·76	5·80	4·76	0·90
Three minutes - - - - -	3·72	2·56	—	0·52
Free N.H. 3 - - - - - -	2·75	1·20	1·15	0·55
Albuminoid (N.H. 3) - - - -	0·62	0·27	0·21	0·085
Nitrite (as N.H. 3) - - - -	—	—	0·03	0·12
Nitrate (as N.H. 3) - - - -	—	—	0·01	0·51

The bacteriological examination shows an improvement, and chemically the effluent is very good.

am much obliged to you for giving me the opportunity of taking samples.

I am, yours truly,

20th October 1902.

C. G. SCHONEBOOM (Chemist to Dutch Government.)

Mr. J. C. Bell.

24 Oct. 1902.

Mr. J. CARTER BELL, Public Analyst, called; and Examined.

15492. (*Chairman.*) You are a Fellow of the Chemical Society?—Yes, and Associate of the Royal School of Mines, Analyst for the County of Chester, and for the Boroughs of Salford, Birkenhead, Stalybridge, Congleton, and Glossop.

15493. Can you give us any information as to the nature of the crude sewage at your outfall?—The analysis?

15494. Yes?—The suspended matter varies from about 10 grs. to 30 grs. to the gallon; I generally give it to the committee in the gallon, and the amount of oxygen required for four hours varies from 3 grs. to about 8 or 9 grs. per gallon, and the albuminoid ammonia varies from ·3 to about ·4.

15495. Does it vary in composition very much?—Yes, it varies very much indeed.

15496. The reaction varies too?—Yes, the Pendleton sewage, we may say, varies almost every hour during the day. Sometimes a large quantity of dye water comes down.

15497. Then it is highly coloured?—Highly coloured, yes.

15498. Then it receives the lime treatment?—When the two sewages are mixed in the mixing house.

15499. Is there any permanent difference in character between the two sewages?—No, not really what you call a permanent difference, there is more dye water in the Pendleton sewage than in the Salford sewage.

(*Mr. Corbett.*) The Pendleton is the small flow by gravitation and the Salford sewage is the large flow that is pumped.

15500. (*Chairman.*) What is the next point at which you examine the product?—After screening the sewage of course it is passed through tanks, and then I examine the tank effluent every day—what we call the tank effluent.

15501. That is to say, after you have added, in the first instance, lime and, subsequently, more lime and copperas?—More lime and copperas. Then it passes through these tanks, and it takes about six hours to pass through these tanks, and then before it goes on to the roughing filter the sample is taken every hour during night and day, and it is then mixed.

15502. Can you state the average composition of the tank effluent?—Yes. In the average composition of the tank effluent the suspended matter varies from 2 grains to five grains to the gallon, and oftener it is 2 grains or 3 grains than 5 grains, 5 grains being rather an exceptional quantity. That is the suspended matter. The amount of oxygen required for oxidising in the four hours varies from 2 grains to the gallon up to about 4 grains or 5 grains, and then the albuminoid ammonia varies from ·2 up to ·3.

15503. And the reaction is fairly uniform?—Fairly uniform.

15504. The amount of dissolved matter, do you estimate that at all?—The total solids, yes. I do not do that every day.

15505. I mean the dissolved solid matter?—Yes, it amounts to from 60 grains to 70 grains to the gallon.

15505.* I forgot to ask you, I think, what was the total dissolved solid matters in the crude sewage?—That varies very much indeed. That varies from 60 grains to 80 grains per gallon.

15506. The chlorides?—The chlorides vary from about 8 grains to the gallon to 16 grains.

15507. You did tell us the albuminoid ammonia?—Yes, and I may just say that after passing through the roughing filter I examine it again.

15508. You examine it again?—I examine it again for the suspended matter.

15509. For the suspended matter only?—Yes, only the suspended matter, and I find that the roughing filter takes out about 75 per cent. of the suspended matter.

15510. Is any other change produced by the roughing filters?—Not worth speaking about. It hardly affects the free lime. I may say that that which goes on to the roughing filters varies from 1 to 2 grains to the gallon, and when it passes through the roughing filter the amount is about the same, and then it goes on to the final filters; and when it has passed through the final filters, the average effluent since March, I may say, has been neutral.

15511. Is the colour gone by the time it reaches the precipitation tanks?—Completely, and in a good effluent it is as clear almost as storm water.

15512. When it has left the precipitation tank the colour has gone, has it?—Yes, fairly. It is slightly oily.

15513. There is still some colour?—It is very rarely there is any dye colour. When it leaves the final filter the effluent is perfectly clear. There is no suspended matter or only very slight, a mere trace, and the amount of oxygen required for four hours varies from ·3 to about ·6 grains per gallon, and the albuminoid ammonia varies from ·08 to ·15 to the gallon.

15514. Do you apply the incubation test at all?—I do.

15515. With what result?—With very favourable results. In nearly every case the amount of oxygen required at the end of the week for the incubation test is always less than the original test.

15516. And there is no putrefaction whatever?—None whatever. I have samples now which I have had since March.

15517. Have you estimated the nitrates?—I have estimated the nitrates, and they vary. I have estimated the nitric acid at from ½ grain to 2 grains per gallon.

15518. Is there any other fact you can tell us which you think will be interesting to us with regard to chemical features?—Well, I have just made a report to the committee about the comparative value of the 3 ft. 6 in. filter, the 5 ft. filter, and the 8 ft. filter. I have had some experiments carried on for two years, and I have it in print here.

15519. Can you say very briefly which gives the best results?—The 8 ft. filter certainly does give the best results.

15520. In proportion to its depth?—In proportion to its depth.

15521. I mean the increase of improvement is the same as the increase in depth?—It is. It produces a better effluent, but then the question is, is it worth while increasing the expense; and I have come to the conclusion that the increased improvement was not great enough to warrant me in recommending the 8 ft. filter; but certainly the 8 ft. is best, there is no doubt about it from the experiments.

15522. And how is the 5 ft. as compared with the 3 ft. 6 in.?—A considerable improvement. The 3 ft. 6 in. did not warrant its adoption.

15523. It was inadequate?—It was inadequate, yes.

15524. The 5 ft.?—The 5 ft. is what we have got now on the large scale.

15525. Giving the average you have given?—Yes.

15526. What do you get with the 8 ft.?—We get more aeration. But we find that when the albuminoid ammonia gets down to a certain state, almost as you might say to a minimum, increased oxidation does not seem to increase the purification, which statement I have proved by many experiments.

15527. What is the albuminoid ammonia in the three cases in the 3 ft. 6 in., the 5 ft. and the 8 ft.?—They have varied of course. They are pretty much the same, but they have varied. Of course, the 3 ft. 6 in. has been down as low as ·14 and the 8 ft. has been as low as ·06, but then it has not kept that up day by day.

15528. And the oxygen absorbed?—And the oxygen absorbed has varied from ·2. We started off on the 8 ft. with oxygen as low as ·2 grains to the gallon, which was exceedingly low, and it has gone up to ·5 and ·6, throughout.

15529. (*Mr. Stafford.*) I suppose, Mr. Bell, will put in that report?—If you would like to have it.

Mr. J. C. Bell.

24 Oct. 1902.

A COMPARATIVE REPORT UPON THE TWO EXPERIMENTAL FILTERS, VIZ :—THE FIVE-FEET AND THE EIGHT-FEET

To THE CHAIRMAN AND MEMBERS OF THE RIVER IRWELL CONSERVANCY COMMITTEE.

GENTLEMEN,

No. 1 Filter was filled with 5 ft. of cinders.
No. 2 " " " 8 " "

The object of the experiment was to ascertain which would give the best effluent after passing the roughing filters and the final filters. The two filters were worked for 23 months. The standard of purity is that 100 gallons of the effluent shall not require more than 100 grains of oxygen to oxidise the organic matter. Therefore the standard is 100, or, in other words, all effluents above 100 are not good, and below 100—the lower the number—the better is the effluent. Thus, for example, the effluent which has a number of 30 is better than one of 60, and the latter is better than one of 90.

The following figures give the average number for each month, the filters having been worked daily :—

Five-feet Filter.	Date.	Eight-feet Filter.
114	May, 1900 -	57
109	June, " -	79
125	July, " -	127
112	August, " -	113
63	September, " -	54
61	October, " -	45
145	November, " -	103
152	December, " -	111
126	January, 1901 -	108
189	February, " -	149
187	March, " -	172
93	April, " -	83
Filters stopped—	May and June, " -	—for cleaning.
66	July, " -	61
68	August, " -	58
70	September, " -	86
70	October, " -	71
61	November, " -	73
83	December, " -	77
93	January, 1902 -	62
124	February, " -	79
147	March, " -	88
107	April, " -	63
147	May, " -	83

The average number for the 23 months is :—
109 for the five-feet filter.
87 for the eight-feet filter.

It must not be forgotten that in the early days of the filters, the five-feet had more work to do than the eight-feet filter.

Thus in May, 1900, the five-feet filter had considerably more effluent passed through it than the eight-feet. This was altered in July, 1900, when the eight-feet was made to work 16 hours against 10 hours for the five-feet filter.

Certainly the eight-feet does show a better effluent in the average than the five-feet, but the question is, whether the eight-foot is worth the extra expense. I think not. My opinion is, that it would be better to make extra filters and pass a less quantity of effluent.

J. CARTER BELL, A.R.S.M., &c.

The Cliff, Higher Broughton,
September 20th, 1902.

15530. (*Councillor Foden.*) I respectfully suggest, Mr. Chairman, that the analyst should give last night's report of what the 8 ft. is doing, for your information. He brought it before the committee last night?—Last night's report was ·4 for the week oxygen consumed, and the albuminoid ammonia was ·1; that is on the large scale.

15531. (*Colonel Harding.*) So far as the albuminoid ammonia is concerned, it is just up to the margin allowed by the Irwell and Mersey Board?—It was up to the Irwell and Mersey Board provisional standard, but I must say, myself, to keep up that ·1 is almost to me an absurdity, because I do not think it can be done day by day.

15532 (*Councillor Mather.*) Are you perfectly sure about the statement you have just made?—Of course it is on a large scale, you clearly understand it is the 5 ft. filter I am speaking about now.

(*Councillor Mather.*) Not the 8 ft. I think the Chairman understood you to say the 8 ft.?

(*Chairman.*) No.

(*Witness.*) Of course, it is the 5 ft. I have not started the analysis of the 8 ft. on a large scale.

15533. (*Colonel Harding.*) On the 5 ft. scale the results come within the provisional standard of the Irwell and Mersey Board?—Yes, I think they are better.

(*The Commissioners proceeded to view the works.*)

AT THE PIT OF THE EFFLUENT FROM THE FINAL FILTERS.

Mr. JOHN ARNOLD, Manager ot the Salford Sewage Works, called; and Examined.

Mr. J. Arnold.

15534. (*Chairman.*) You are Manager of the Sewage Works?—Yes.

15535. How long have you been in charge?—Five years before this scheme was commenced. With the exception of this one contract (the aerating filters) the whole of the works have been carried out by myself, such as the alteration of the tanks, the making of the roughing filters, and the chemical appliances, have all been carried out by my own men under my own supervision, of course, always under the direction of my committee.

15536. At present, these beds are being worked with an eight hours flow?—They are working two hours and resting two hours night and day. That commenced from this week. They have been working eight hours some of them. You see, we started to incubate these beds working them half an hour per day for a fortnight, then one hour per day for a fortnight, then two hours, then five hours, then seven and a-half hours, up to eight hours and now 12.

15537. Now 12?—Yes, working alternately two hours.

15538. They are working 12 hours, not eight?—They are working 12 hours; they commenced this week.

15539. Would you see any difficulty in making an experiment by which the flow could be continued throughout the 24 hours? Only discharging in the 24 hours as much as you do now.?—I see no difficulty however, it is a very easy matter for me to do, having beds at my disposal for it.

15540. (*Colonel Harding.*) You have small beds?—Yes, I will show them as we go back. We have a model of the whole scheme.

15541. Could the manager at the same time try the experiment of the speed of the passage through the beds?—I have taken all these details minutely.

15542. (*Chairman.*) Can you tell us from your knowledge how long it takes to go through these 5 ft. of filter?—About 28½ minutes from the top to when it comes out at the bottom, before we see signs of trickling at the bottom of the bed.

15543. But no experiment has been made by means of a colouring fluid such as fluorescine while the thing is in action?—I do not quite follow.

15544. Supposing you were to pour on to the top of this bed a coloured fluid, how soon would it make its appearance below?—It would be all gone by the time it got to the bottom of the filter.

15545. No, you would see the colour, and you easily recognise the fluorescine?—There would be no difficulty making that experiment.

15546. (*Colonel Harding.*) Not at all. How did you arrive at the 28½ minutes?—By setting a man to watch.

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15547 (*Chairman.*) We want to know when the bed is in action how long it takes. How long is the interval between the pouring of the coloured fluid on the surface of the bed?—And the time it finishes draining out at the bottom?

15548. Its first appearance at the bottom?—That is exactly what I did with these beds. We had a man standing at the top in possession of the valve. It was filled up exactly as you see it now. I had another man standing here with a watch. The man in possession of the valve let go; we opened the water and commenced to sprinkle, and in 28½ minutes from the time it first touched the top of the bed we commenced to see a slow trickling from the bottom.

15549. (*Colonel Harding.*) That is not what we want?—Then it accumulated a great deal. It got faster and faster and faster after we had shut off the feed to the bed, it was just half an hour in draining.

15550. (*Chairman.*) That is not quite exactly what we want to know. While the bed is in full action while the fluid is regularly passing down from the top of your bed to the bottom of the outlet, we want to know how long it will take between the pouring of the coloured fluid on the surface and the first appearance of that coloured fluid at the outlet?—It will be a very easy matter to find out.

15551. The substance is called fluorescine?—You want me to trace it right through, and see the time it takes.

15552. Until it shows itself at the bottom. You can do that—I can do that.

15553. How will you colour it?—We can colour it with anything. We can ascertain it by pouring a bucket full on the top.

(*Colonel Harding.*) It must be when the filter is in full working.

15554. (*Chairman.*) It would be a vertical passage, not a horizontal passage, down to the drain. How much of the total sewage are you treating in this way?—We are not working the whole of it on these beds, but the whole of the sewage is going into the canal as a tank effluent. I will try to explain that to you. For instance, now the filters are all working; they are taking all the sewage we get at the works. These filters will run for two hours. Then we stop them all, and then we do not go on with any further treatment during the time the filters are resting, and the sewage goes into the Ship Canal as a tank effluent.

15555. And during the period of rest the precipitation tank effluent is going direct into the canal?—Into the canal.

15556. You are working 12 hours now?—Yes.

15557. Then to deal with the whole of your sewage you want twice your plant if you are to work at the rate you are working now?—We are only working eight out of the 15 beds; we have not yet concluded our scheme.

15558. Then it is purely temporary?—Purely temporary.

15559. When your plant is complete you will be able to treat the whole of the sewage?—We hope to treat the whole of it.

15560. But at present, owing to the incompleteness of your plant, you are practically only treating half of it?—Yes.

15561. (*General Carey.*) And you are obliged to discharge the rest of it as a tank effluent?—Yes, that is our position at present.

15562. (*Chairman.*) Our attention has been directed to the scum at the outlet. You are inclined, Mr. Arnold, to think that that greasy appearance on the scum is due to a back flow?—Yes, which is partly composed of our tank effluent, which is passing from here and is backed up as the Ship Canal rises. Then, sir, you see it forms a whirlpool, and we cannot get rid of it.

15563. (*General Carey.*) Then that scum will disappear, or ought to disappear, to a great extent when your tank effluent ceases to be discharged into the canal. When your beds are complete you will not put any in?—No.

15564. Then you think you will get rid of that scum?—Yes, we think we shall get rid of that scum, except what you see coming down now, which is very little at a time.

15565. (*Chairman.*) Mr. Corbett, I understand that you are dealing with half the sewage, and that the remainder passes as tank effluent into the canal?—(*Mr. Corbett.*) Yes, that is the engineer's estimate.

(*The visit of the Commissioners to the Sewage Works concluded.*)

OLDHAM.

Friday, 24th October, 1902.

PRESENT:

Colonel T. W. HARDING, J.P. (*Chairman*).

Dr. JAMES BURN RUSSELL. | Mr. T. J. STAFFORD, F.R.C.S.I.

Mr. F. J. WILLIS, *Secretary*.

ALSO PRESENT:

Dr. A. C. HOUSTON. | Mr. COLIN C. FRYE.

MINUTES of Evidence taken at the Sewage Works at Oldham.

Dr. J. Wilkinson and Mr. A. H. Valentine.

Dr. JAMES WILKINSON, Medical Officer, and Mr. A. H. VALENTINE, Analytical Chemist, called; and Examined.

15566. (*Chairman.*) Dr. Wilkinson, you are Medical Officer of Health for the borough of Oldham?—Yes.

15567. And you are in charge of these works?—Yes.

15568. How long have they been in operation?—About six years, I think. I have been here four or five years, and they were in operation about twelve months before that, I think.

15569. Your sewage purification was just at the beginning of ——?—In 1897 the first filtration beds were started.

15570. Before that you had no sewage works?—No sewage works.

15571. What is the population drained by those works?—About 139,000.

15572. And what is the average dry weather flow?—It is estimated at about five million gallons, four and a-half to five millions.

15573. Have you, in your sewers a separate or a combined system?—A combined system.

15574. To what extent does it influence the works?—That I can hardly tell you from the overflows in the sewers. I cannot tell you the exact amount that goes from them; the rainfall that they take.

15575. But you do receive considerable dilutions?—Yes.

15576. Do you think you receive three dilutions?—Yes, quite.

15577. 15,000,000 gallons?—Yes.

15578. Your main sewers are capable of bringing that?—I think we have had as much as 19,000,000 gallons in twenty-four hours.

15579. Then I shall be right in taking it that you receive three to four dilutions at the works?—Yes, I should think so.

15580. When the works were first begun they were started on the system of chemical precipitation?—Yes.

15581. Was that by lime?—By lime and copperas.

15582. And in the first instance that was all that you did?—Yes.

15583. You separated the suspended solids; the dissolved impurities were allowed to go forward into the streams?—Of course, the bacteria beds were put down as an experiment to begin with.

15584. That is years ago?—In 1897, I think, the first bed was put into use.

15584*. I need not, I think, trouble to ask you many questions about the experimental works which were then carried out. Any way, they led you to adopt a certain system, did they not?—Yes.

15585. Will you tell us briefly what that system is?—We found the system was unsatisfactory.

15586. What system is it?—Precipitation, followed by the bacteria beds. It gave a good effluent, an effluent coming below the standard required, but it was found after a time that the effluents were obtained whether we used precipitants or whether we did not.

15587. Then, do I understand you have abandoned precipitants?—Then we abandoned precipitants.

15588. What is the capacity of your tanks relatively to the flow. Am I right that they contain about a quarter?—If we were to use the whole of the tanks they contain nearly half a day's flow; but we find that we cannot use them; in fact, two of them are turned now to another use, and we keep those tanks going, as a rule, which hold about a quarter of a day's flow, roughly.

15589. You do not add any chemicals, and you get how much precipitation. What is the quantity of suspended solids in your crude sewage as it arrives at the works, on an average?—That I cannot tell you.

15590. Can you tell me, Mr. Valentine?—(*Mr. Valentine.*) The average is about 24 or 25. (These numbers are entirely based upon experimental analyses dating from September 1st, 1902.)

15591. 24 or 25 grains per gallon?—Yes.

15592. Then, after this natural precipitation which Dr. Wilkinson has been telling us of, what is the amount of suspended solids in the effluent from the tanks?—I should say, as far as my series of analyses have gone, about 10 in the tank effluent.

15593. Ten grains per gallon?—Yes, sometimes it is more; sometimes it has been down as low as 4 grains. At other times it would come to 18 grains or 19 grains; but I think the general average is about 10 grains.

15594. So that on that of 25 grains you precipitate 15 grains?—Yes.

15595. Then, Dr. Wilkinson, what do you do with the sludge so precipitated?—(*Dr. Wilkinson.*) It is pressed, and then a great deal of it is fetched away by the farmers.

15596. In the form of cake?—In the form of cake.

15597. Do you press the whole of it?—I cannot say we have. We attempt to press the whole of it, but there have been one or two occasions when we have found the tanks choked that we have blown it out into a large valley. Our idea is to compress the whole of it, but on a few occasions in the summer we have not been able to do that, and we have deposited it in the valley to dry there.

15597*. Have you found any difficulty in pressing sludge of that kind as compared with the pressing of sludge with which lime is mixed?—We have to mix lime with it to press it.

15598. You find, in order to successfully press it, you must add lime, only you add the lime to the sludge, not to the sewage?—Yes.

15599. To what extent do you add lime to the sludge?—(*Mr. Valentine.*) About 20 per cent.

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15600. That gives a certain value to the cake, does it not?—(*Dr. Wilkinson.*) Well, I suppose it does.

15601. Do you get anything for the cake?—We make a nominal charge of 1s. a ton; but we do not often enforce it. That is supposed to be the charge we make. It is giving it away, you may say.

(*Alderman Simister.*) We are not in an agricultural district here.

(*Chairman.*) There is no demand for it?

(*Dr. Wilkinson.*) No.

15602. When you say that 20 per cent. of lime is added you mean that into the composition of the cake the lime enters to the extent of 20 per cent, but in proportion to the sludge you add about 6 per cent?—(*Mr. Valentine.*) Yes; I made a rough calculation the other day, and I went down and questioned the men, and it seems they add about 6 per cent.

15603. Now, Dr. Wilkinson, I think you have told us all that is necessary about the tanks, unless you yourself wish to add anything in answer to the questions I asked you?—(*Dr. Wilkinson.*) No.

15604. I will ask you now what second process do you pass the sewage through?—Bacteria beds.

15605. Contact beds?—Contact beds.

15606. Then, tell us, please, do you pass it through double contact or single?—Single contact.

15607. Just explain to us the extent of your beds and their construction and character. At present there are about five acres, is not that so, Mr. Valentine?—(*Mr. Valentine.*) Yes.

15608. You have about five acres of beds?—6 acres 3 roods, nearly seven acres; and we are in process of constructing another area of nearly three acres, making altogether nearly nine acres.

15609. Now, what is the method of construction; are they simply dug out of the ground?—The ground is simply excavated. Some part of the sides is excavated and some is additional, in order to get the necessary levels. The sides are boarded with 3in. planks. Of course, they are made level, and battened down. Some of the beds are fitted with screened ashes, ordinary mill ashes.

15610. What do you put at the bottom?—Two rows of tiles, ordinary field tiles.

15611. You say two rows; two rows in what width?—In the beds; the beds vary in shape very considerably. (*Mr. Valentine.*) We shall be able to show you the beds in course of construction.

15612. I want to get this on the evidence. To what extent are these drained. You have two rows of tiles?—(*Dr. Wilkinson.*) Two rows in each bacteria bed.

15613. In each bed?—In each bed. There is a double row at the bottom of the bed.

15614. No transverse rows?—No.

15615. Just those two rows?—Just those two rows, yes.

15616. And you find that sufficient for drainage if you have coarse material at the bottom of the bed?—Yes.

15617. And you do, in fact, put coarse material at the bottom of the bed?—Over the tiles.

15618. What is the material you use for filling the bed?—I should mention that the floor of the bed is levelled down, as as to fall towards these rows of tiles, and then the tiles are covered with, perhaps, 8in. or 10in. of very coarse clinker, the coarsest they can pick out, and then the bed is filled with screened clinker. Some of the beds are filled with ordinary mill ashes, screened, everything below a quarter of an inch being taken out, and others are filled with screened clinker from the destructor works to the average depth of 3ft., and then carriers are placed across the top of these beds to distribute the sewage.

15619. Do you find any settlement of sludge in those carriers?—Not very much. There is a length to be swept out occasionally.

15620. Then, some of the suspended solids, most of them probably, in the tank effluent go on to the beds?—Yes.

15621. Do you find that it remains on the surface of the beds?—Not in the coarse beds. We have had

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one bed constructed with an upper layer of fine material, and in that bed it did clog the surface or remained on the surface, and eventually clogged it.

15622. Have you found any advantage or disadvantage through keeping it on the surface?—Well, we have never estimated really the capacity of the beds. We only go by the rate of time it takes to fill the beds with the flow.

15623. Have you found any advantage or disadvantage in keeping the suspended solids on the surface?—At present I cannot say I have found any advantage or disadvantage.

15624. You have found this disadvantage, that it is necessary to rake the surface?—In that case, yes.

15625. But in the other case it is possible that the solids will go down with the bed of the filter?—It is possible they may.

15626. And from your system of gauging, which you say is not a very accurate way of measuring, what is the idea you have gathered as to the degrees of capacity?—I am under the impression there is not much decrease of capacity after a few months' work.

15627. You are under the impression, now that your beds are established, that you will maintain the capacity?—Yes; there may be a slight decrease, but they remain about the same.

15628. I take it, if in the course of a number of years the beds are getting choked up, you think you can get the material taken out and washed and put in again?—Undoubtedly it could be washed.

15629. At a cost which would not be prohibitive?—At a very moderate cost.

15630. These are your first contact beds?—Our first contact beds. The first that we put down were put down in the early part of 1897.

15631. What is the total area, are you able to give it to me, of the first contact beds?—They are all first contact.

15632. These are all first contact beds?—We have no second contact.

15633. Except experimental?—Except experimental.

15634. Then the whole of the area you have mentioned is first contact. Now, what sort of result are you getting, or shall I ask your chemist. What sort of result do you get from the single contact?—(*Mr. Valentine.*) Filling once a day I generally get them below the limit, as regards oxygen absorption. I have been lately taking all the filters, with a few exceptions, twice a day, and, as a rule, I have got very much below the limit. This, however, has been during a period of somewhat wet weather.

15635. Give us a typical analysis. I do not want a single analysis. If you can give it to me, I want an average of a considerable number. Can you give us the oxygen absorbed?—(*Dr. Wilkinson.*) About 6 grains per gallon.

15636. If you can give me the oxygen absorbed, and the albuminoid ammonia in the crude sewage and in the tank effluent, that will be convenient?—(*Mr. Valentine.*) That is in my last report. (*Dr. Wilkinson.*) It contains a tabulation of the groups of beds separately. (*Mr. Valentine.*) The sewage is very strong indeed.

15637. These are averages for one fortnight?—The last fortnight.

15638. Do you consider them typical of the general condition?—No, not in the winter.

15639. What I want is a sort of average?—You will get from the annual report.

15640. Dr. Wilkinson, you have put into my hands a report from which I see that averages over a year from certain filters, namely, Nos. 1, 2, 3, and 4, give the following results:—In the crude sewage the oxygen absorbed in a four hours' test is 4·31; tank effluent, 2·21; in the filtrate, ·64?—(*Dr. Wilkinson.*) Yes.

15641. May we take it that that is a fair average of your general work?—Yes, I think so, taking the whole year.

15642. The albuminoid ammonia would probably be rather higher, would it not?—I should think it would rather. I can hardly give you that, because up to the present time we have not done the analyses of the albuminoid ammonia regularly. You see the Irwell and Mersey Board take the standard of the oxygen absorbed, and it has been the principal idea in taking our analyses to ascertain that we keep below their standard.

15643. This average you have given me is below the standard?—Yes; theirs is 1.

15644. You considered their effluents as required to be satisfactory?—Yes; they take the filter effluent.

15645. But your sewage, judging by the average of the oxygen absorbed you have given me, is weak?—It is not a very strong sewage; but it has increased very much in strength in the twelve months.

15646. Is this a water closet town?—It is gradually becoming so now.

(*Alderman Simister.*) We have nearly 11,000 now on the water closet system.

15647. (*Chairman.*) Whence this dilution of your sewage. Is there a very abundant water supply, or does it come—of course, it does come to some extent—from surface waters, and is there any discharge from manufactories. Does condensed water, for instance, find its way into the sewers?—Yes, from the mills.

15648. Condensed water from the mills finds its way into the sewers?—Yes, but a large proportion of our mills condense the water, and use it over again, until it becomes too bad to use, and then they send it down to us.

15649. Cotton mills, I take it, do not produce any trade effluent of any volume?—No, except when they empty their reservoirs to clean them out.

15650. Have you any trades other than the cotton trade that supply other effluents?—Practically none.

15651. Then, your sewage is mainly domestic sewage? Mainly domestic. There are a few dye works and a brewery or two, but nothing of any importance.

15652. Then, the long and short of your experience in the treatment of sewage is that, in your case, with your somewhat weak and dilute sewage, you are able by natural precipitation, followed by single contact, to get results which are satisfactory to the Rivers Board?—Yes. But we are constructing some of the beds at the present time in such a manner that they can be readily converted into second contact.

15653. Have you anything to guide you as to the results you are likely to get by second contact?—We have been making some experiments with small second contact beds, with the idea more of having septic tanks and treating the effluent from septic tanks, rather than by ordinary precipitation or ordinary sedimentation tanks. They have been mainly used in connection with septic tanks. I do not think we have tried any second contact in connection with the ordinary sedimentation tanks.

15654. So that you have no figures that you can put before us?—No.

15655. But the intention of your Corporation is to move in that direction?—Yes.

15656. So as to get a still better effluent?—Yes; that is, provided that the first contact does not remain satisfactory. We are expecting that our sewage is likely to increase in strength, and that the first contact, unless we only fill the beds, say, once a day, will not be satisfactory.

15657. So that you do foresee definitely that there will be a necessity for second contact beds later on?—Yes, I think so.

15658. And you are proceeding with experiments in that direction?—Yes.

15659. It would be interesting to have from you, Dr. Wilkinson, some idea of the cost of the considerable area of beds which you have put down?—Well, I can hardly give you that; but it was estimated some time back from the earlier beds that it would cost us about £700 an acre; but I do not think we have any accurate knowledge as to the cost.

15660. Has no note been taken, in the construction of six acres of beds, of what their cost was.

(*Alderman Simester.*) The cost varies very much with the cost of ashes and cinders.

15661. (*Chairman.*) We take it that in filters constructed as are these the main cost is the material with which they are equipped?—Yes, I think so.

15662. What do you pay for that material per cubic yard?—At present we are paying for the ashes 2s. 6d. per ton, screened.

15663. Do you happen to know what that comes to per cubic yard?—No; I do not.

15664. Would it be possible for your Corporation to give to the Committee more closely what has been the cost of more recent beds?—I think it might. I think we might be able to do that. (*Mr. Valentine.*) Mr. Bentley will be able to tell you. (*Dr. Wilkinson.*) I do not think he can tell you. You can ask him if you like, but I do not think he knows.

15665. Unless the information is authentic and definite, it is of no use?—Some of them we have had made by our own hands, and others we have let by contract.

15666. The impression upon your own mind is that the cost is about £700 per acre?—Yes, that is it.

15667. But you tell us, frankly, that that is somewhat vague, and not to go upon, but we are to take it for what it is worth?—Quite so.

15668. (*Dr. Russell.*) What is the depth of the bacteria beds?—The average depth of the beds used to be 2ft. 9in. We used to make them 2ft. 9in., but we increased them to 3ft., so that you may take the average as 3ft. By the average I mean that they are somewhat deeper in the portion over the drains where the underlying drains are, and somewhat shallower at the side. At the side they may be just below 3ft., and in the centre, where the drains are, they would be rather over 3ft.

15669. The material graded to these drains?—To these drains, yes.

15670. (*Mr. Stafford.*) I suppose we may take it that you are not satisfied with the first contact bed, not satisfied that it is producing a proper effluent?—Yes; if we can keep our tanks clean and free from any septic action we get a very good result, but our difficulty comes in in keeping our tanks sufficiently clean, emptying them sufficiently often of the sludge to keep them clean. They get sick, especially in the hot months. That is where our difficulty comes in.

15671. (*Chairman.*) Tell us what is the nature of the septic difficulty which arises; what is it? You say you endeavour to avoid septic conditions, and that your difficulty arises from the nature of the conditions?—The difficulty is that the tank effluent gets very much stronger, and the single contact beds won't bring it below the standard.

15672. By stronger, do you mean that it contains less suspended solids?—Yes; of course you get a large amount of the sludge then converted into liquid material.

15673. You think the dissolved impurities are also greater?—Oh, yes.

15674-5. Have you anything to substantiate that view?—Yes.

15676. Have you a typical analysis?—Here is the sewage taken through several months. It is the old septic tank which has increased very considerably. The first contact bed comes below the standard.

15677. The reduction in the septic tank effluent is comparatively little upon the crude sewage, but to what extent has the septic action arisen?—These are complete septic tanks. That is a complete septic tank.

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15678. With what flow?—Filling in about 16 hours.

15679. Your experience is somewhat different from what has been put before us in other places. It has been not unusual to find that the septic tank with 24 hour flow has given a reduction of the impurities to somewhere about 50 per cent.?—It has not with us, I think. Of course there may be in that tank. I do not know that the arrangement for emptying the tanks has been very satisfactory, and, therefore, we have got a considerable quantity of the scum coming over as well, breaking up and coming over, and that may account for a considerable amount of suspended solids in the tank effluent.

15680. Then I think that is all we need ask you, and if you will be good enough now to show us round the works we shall understand your evidence better from what we see.

At the outfall of the main sewer.

15680*. (*Chairman.*) I find that in many places they use cotton waste instead of paper?—(*Alderman Simister.*) In some cases the manufacturers have found it economical to supply paper to prevent the use of cotton waste. We have hundreds of tons taken out sometimes in a year.

At the filter beds.

15681. (*Chairman.*) You are dealing with the whole of your flow by the first process of precipitation?—(*Dr. Wilkinson.*) Yes, the whole of it.

15681*. And to what extent are you dealing with it by the second process?—About half of it.

15682. And you are extending these first contact beds, with the intention of dealing with the whole of it?—Yes.

15683. And within what time shall you be dealing with the whole of it by single contact?—I can hardly answer that; it depends on so many considerations.

15684. The works have not been erected by the Corporation?—No; we are gradually extending section after section. The last section is nearly two acres.

15685. Have you land?—Oh, yes; plenty of land.

15686. You have land?—Any amount of land.

15687. I understand you are going on?—Yes.

15688. But you are unable to name a date when the work will be complete?—No, I could not.

15689. What is the total area available for sewage treatment?—We have 70 acres altogether.

15690. What is the character of the land? Is it sandy or clayey?—Clay principally, with sandy pockets, but principally clay.

15691. It is not suitable for processes of land treatment?—Yes, we could not use it in that way.

(*The visit of the Commissioners to the works concluded.*)

FIFTY-FOURTH DAY.

16th December 1902.

PRESENT:

Sir MICHAEL FOSTER, K.C.B., F.R.S., M.P. (*Chairman*).

Sir WILLIAM RAMSAY, K.C.B., F.R.S.
W. H. POWER, Esq., C.B., F.R.S.
Colonel HARDING.

Major-General C. PHIPPS CAREY, C.B., R.E.
T. G. STAFFORD, Esq., F.R.C.S.I.

F. J. WILLIS, *Secretary*.

ALSO PRESENT:

Dr. A. C. HOUSTON.
Dr. G. McGOWAN.

Dr. H. T. Bulstrode.

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H. T. BULSTRODE, Esq., M.A., M.D., Medical Inspector of the Local Government Board, attended to discuss the question of the discharge of sewage into estuarial waters with special reference to shell-fish.

(*Chairman.*) Perhaps, Dr. Bulstrode you will be so good as to make a preliminary statement.

(*Dr. Bulstrode.*) I propose, with the permission of the Commission, to give quite a brief summary of so much of the shell-fish industry as is necessary for a proper understanding of the relations which obtain between shell-fish and disease.

In the first place with regard to

OYSTERS.

Oysters must be divided into English oysters and foreign oysters. In this country there are several natural oyster estuaries, such as the Crouch, the Roach, and the Colne in Essex, the mouth of the Thames between Essex and Kent, and, in Cornwall, the Truro and Helford rivers. In these estuaries natural spatting or reproduction of oysters takes place, and oyster culture consists in certain farming operations with which it is hardly necessary for me to trouble the Commission. A full account of such operations will be found in the Local Government Board Oyster Report, and the maps furnished therein will illustrate the narative given in the letterpress. It is, however, essential to comprehend that, in the course of these operations, the oysters are moved from one part of the estuary to another, or even from one estuary to another. One of these removals consists in placing the oysters, prior to their despatch to the market for consumption, in what are known as "fattening" beds, *i.e.*, areas which experience has shown are well fitted for the nutrition and development of the oyster. If these fattening beds are in sewage polluted estuaries, or near to drain outfalls, there is risk of the contamination of the oysters by sewage organisms. It is also the practice in some estuaries to store oysters prior to sale for food in ponds or pits. There is another form of storage in ponds during the winter months, so as to prevent the destruction of the oysters by frost or water-borne sand, but into this question we need not now enter. The storage or market ponds may be placed in the vicinity of sewers, and then there is danger of contamination. Finally, the oysters may be "washed" in polluted water, or they may be stored in shops under conditions which, although not likely to produce what is termed specific infection, may result in the consumers of such oysters in attacks of gastro-enteritis, leading to serious or even fatal results. From these observations it is clear that there should be some means for preventing the "fattening" or storage of oysters intended for immediate consumption in the vicinity of sewage polluted water.

It is, too, necessary to insist that in natural oyster estuaries or on the littoral oysters for immediate consumption should not be dredged up from the neighbourhood of sewer or drain outfalls.

FOREIGN OYSTERS.

Oysters are imported into England and Wales from America, France, and Holland, as also from Ireland and Scotland.

American oysters which are shipped at New York are packed in barrels, the oysters being placed with their concave shells downwards, so as to conserve as long as possible the water contained between the valves of the oyster. The oysters are closely packed, so that by mechanical pressure the valves are prevented from opening. These American oysters may be out of water from 10 to 14 days. On their arrival at Liverpool or Southampton the oysters are either despatched direct to the retailer for sale for consumption, or they are sent to layings in the English, Welsh, or Irish estuaries, such as those in the Menai Straits, at Fleetwood, or at Cleethorpes in the north, or to places such as Southwick, Poole, Emsworth, the Medina, etc., in the south. The object of this relaying of the American oysters is to furnish the market with a supply of oysters during those times of the year, July and August, for instance, when the weather is too warm to allow of direct importation, and when the law of this country aims at preventing the "native" oysters from being consumed. The oysters for relaying are imported very generally in the month of April and May, and they are in good condition when the summer demand for cheap oysters begins. It is these American oysters which are so largely consumed by the poorer portion of the community, who are prepared to pay from 8d. to 1s. per dozen, and who make periodical daily excursions to seaside resorts, such as Southend, Margate, and Blackpool. Outbreaks of enteric fever amongst trippers of this class has been attributed to the consumption of oysters from Southend, of cockles from Leigh, and of mussels from Blackpool. French oysters are imported from many parts of France, as also are oysters which are known as Portuguese, and which came originally from the Tagus, but which have now obtained a natural habitat at certain places on the French littoral. Both the French and Portuguese oysters are largely relaid in our waters, and in addition to the nearly mature oysters, an enormous number of quite young French "brood" is imported for the purpose of being grown in certain of our estuaries. An account of this industry will be found in the Local Government Board Oyster Report, and I do not propose to trouble the Commission with the details in this preliminary statement. Dutch oysters are imported in very large quantities from Holland via Flushing, and other ports, and as they do not stand relaying well, they are used almost entirely for immediate consumption. The distance is so short that they can be placed upon the English market as quickly as many of the home-grown oysters, and as they belong to the same species they fetch a relatively high price (about 2s. a dozen).

From the foregoing statement it will be seen that as regards the cause of pollution, the greatest importance attaches to the position of the "fattening" beds and storage ponds in respect of "native" and directly-imported produce, but with regard to retail foreign oysters, the position of the "layings" is the point to which attention should be directed. It has, however, to be added that some foreign oysters are kept previous to consump-

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tion in storage ponds upon our littoral, and instances of this practice may be found at Poole, Emsworth, and other places.

In addition to the foreign oysters above referred to, a large number of "deep sea" oysters, which are used largely for purposes of oyster sauces, are introduced into this country at Grimsby, Brightlingsea, and other ports, and such oysters are relaid and stored much in the same fashion as other oysters. They are, too, shelled and preserved in tins.

I will now place before the Commission a few figures relating to the number of foreign oysters introduced into this country. These figures were furnished to me by a leading oyster merchant at the time when I gave evidence before the Select Committee of the House of Lords, and there will not I think be any objection on his part to my placing the figures before the Commission.

15692. (*Chairman.*) You mean the numbers imported?—I can hand in a table with regard to the number imported month by month into this country.

15693. From the different sources?—From the different sources.

15694. Does that distinguish between those which are for direct consumption and those which are for laying down?—Yes, I can give them roughly. With regard to American oysters, about 44,000,000 would be for laying down and 40,000,000 for immediate consumption.

15695. You can let us have that table?—I can hand that in.

THE WORLD'S YIELD OF OYSTERS.

* Rough estimate of the total number of oysters obtained annually from the sea (North America, 5,572,000,000; Europe, 2,331,200,000):—

United States of America -	5,550,000,000
Canada - - - -	22,000,000
France - - - -	680,400,000
Great Britain - - -	1,600,000,000
Holland - - - -	21,800,000
Italy - - - - -	20,000,000
Germany - - - -	4,000,000
Belgium - - - -	2,500,000
Spain - - - - -	1,000,000
Portugal - - - -	800,000
Denmark - - - -	200,000
Russia - - - - -	250,000
Norway - - - -	250,000

N.B.—Very few of the oysters in Europe go direct from their natural beds to the consumer.

In the United States of America about 30 per cent. to 40 per cent. go direct from their natural beds to the consumers.

* These figures and statements have been extracted from the "Encyclopædia Brittannica," Vol. XVIII., 9th Edition.

ROUGH ESTIMATE of OYSTERS imported into this Country during 1896.

——	American.	French and Portuguese..	Dutch.	TOTAL.
Total - - - - -	84,000,000	50,000,000	4,500,000	138,500,000
Laid down - - -	44,000,000	37,500,000	Nil.	81,500,000
Consumed at once - - -	40,000,000	12,500,000	4,500,000	57,000,000

MONTHLY IMPORTS OF BARRELS OF AMERICAN OYSTERS.

——	1890–91.	1891–92.	1892–93.	1893–94.	1894–95.	1895–96.	1896–97.	1897–98.	1898–99
September - -	—	—	—	—	25	—	—	—	—
October - - -	2,548	1,908	947	917	1,426	1,428	1,894	273	1,185
November - -	7,221	11,907	5,394	5,905	8,706	7,709	5,650	6,198	7,262
December - -	11,724	9,995	9,364	7,887	10,154	7,472	7,059	8,521	9,153
January - - -	7,345	10,412	6,053	10,777	7,669	8,139	6,937	6,486	8,000
February - -	7,890	13,802	2,596	6,603	2,548	7,550	3,969	6 295	—
March - - -	17,188	17,344	10,027	19,014	7,868	10,892	14,107	13,192	—
April - - -	29,425	36.488	25,426	18,947	23,712	32,025	26,369	20,952	—
May - -	15,152	7,379	9,105	5,298	7,959	3,140	4,355	2,332	—
	98,493	109,235	68,912	75,348	70,067	78,355	70,340	64,249	25,600

Each barrel contains on an average about 1,200 oysters.

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EXPORTATION OF OYSTERS FROM FRANCE TO ENGLAND.

(Amounts expressed in thousands).

YEAR.	First month.	Second month.	Third month.	Fourth month.	Fifth month.	Sixth month.	Seventh month.	Eighth month.	Ninth month.	Tenth month.	Total for each Year. Twelve months.
1896 - -	700	1,900	14,000	27,200	35,500	36,300	38,200	39,200	41,400	45,000	49,300
1897 - -	100	300	9,900	19,700	38,400	39,800	47,800	48,800	49,800	50,100	50,300
1898 - -	200	800	7,400	10,700	26,900	–	–	–	–	–	—

To obtain the monthly quantities deduct the total quantity given for the preceding month from the total for the month required. Thus to find the quantity for February in each year—

1896 - - -	1,900 — 700 =	1,200
1897 - - -	300 — 100 =	200
1898 - - -	800 — 200 =	600

The chief centres of exportation are St. Nazaire, Bordeaux, and La Rochelle.
The above numbers include both French and Portuguese oysters.
It is estimated that about ¾ of these oysters (75 per cent.) are for relaying.

Chaille Michel,
Ostruenltrue, Marennes.

7 June 1898.

MUSSELS.

With regard to mussels. Mussels are used partly for bait and partly for food, and any regulation with regard to the food can hardly apply to bait.

15696. About what proportion?—I am afraid I can hardly answer that question. Mussels are imported largely from Holland, and those that are imported from Holland are used very largely for food. Some of the chief centres in England are Morecambe Bay and the Wash, and places on the south coast, such as Southwick, the Exe, the river Teign, &c. Also there is a growing practice of taking young mussel "brood" from certain sea areas and putting them down in estuaries. On the Norfolk coast there are a large number of these "layings" as they are called, and a considerable number of fishermen obtain their livelihood by this mussel farming. The Buchot system of mussel culture which obtains in France has not, I believe, proved successful in this country.

15697. Those are for food?—Those are mainly for food. Of course with regard to mussels which may be collected wherever they are distributed by nature, the risk is a question of proximity to sewers, but I may also add that I know of several places where the mussels are taken from situations which are relatively remote from pollution, and they are afterwards washed in the vicinity of sewers. It is hardly desirable to give names, but I have seen that practice in connection with very large branches of the industry.

COCKLES.

With regard to cockles. Those may be collected anywhere where they are found to be growing, and in the large expanses of sand which are uncovered at low water you find them very generally, more particularly in Morecambe Bay, where vast expanses of sand are uncovered. The cocklers go out sometimes for distances of four or five miles to collect those cockles. This is the case at Penclawdd in South Wales, near the Gower Peninsula. There is also a large industry at Leigh, in the mouth of the Thames, and also in the Wash. The cockles in some parts of England are sent away in their shells, but in others they are partially boiled by putting in "coppers"; they are then "riddled" to separate the "fish" from the shells, and the "fish," either fresh, salted, or pickled in bottles, despatched to market. I have here photographs of the method of boiling whelks. (*Photographs exhibited.*) Although these photographs relate to the whelk industry, cockles are treated much in the same way. Then cockles are also imported from Ireland and from Scotland.

As regards whelks, those are collected anywhere along the coast. They may be collected near the sewer outfalls. Those are boiled in the manner shown in the photographs.

There is inter-communication as regards shellfish between all parts of the British Isles, and, moreover, large quantities of shellfish are imported from abroad. It is therefore necessary that any regulations to be of the greatest utility should have reference to all parts of Great Britain, and that cognisance should be taken of the foreign importations. I also submit here a copy of a memorandum relating to the shellfish industries of Scotland and Ireland. I have no personal knowledge of these industries, but the abstract of the reports of the Fisheries Departments which I have made may be of some use to the Commission in helping them to judge of the relations of the shellfish industry of the several parts of the British Isles (*see* Appendix A.). Well, that is all I propose to say about the industry to convey a general idea of the points which it is necessary to emphasise. Briefly, the whole problem may be summed up. These oysters, mussels, and cockles may be found, or may be placed, near to sewer outfalls, and in these positions they are liable to become contaminated by sewage.

Shall I go on, or would the Commission wish to ask me some questions with regard to the industry?

15698. (*Colonel Harding.*) I did not quite gather what was the nature of the food which caused the oysters to fatten in particular places?—Well, I am afraid that is rather a difficult matter. It is doubtful whether the oyster has any selective power *quâ* food, and it must feed on such of the flora and fauna of the estuary in which it is as passes with water over its branchiæ. The flora may possibly have some relation to the nature of the bed of the estuary, but that is a point which is certainly undetermined.

15699. (*Chairman.*) Which are the chief distributing centres of the American oyster?—The American oysters come entirely——

15700. They come to Liverpool in the first instance?—Nearly all to Liverpool, and some to Southampton; those two places.

15701. And when they are laid in England, where are they laid, and from whence are they distributed?—Well, those that come to Liverpool are laid down very largely in the Menai Straits, at Fleetwood, and at Cleethorpes. You will find a map in this book of all the layings in England.

15702. What book is that?—This is the Oyster Report.

15703. Oh, your Oyster Report, quite so?—Yes. Well, with regard to the nature of the illness which is associated with shellfish, it is important to remember that enteric fever is not the only illness.

15704. Before you go on to that, I see that you suggest that we should ask the Fishmongers Company. And this refers to the industry, does it not?—Quite so.

15705. But for our purpose do you think we require to know very much more than you have given us just now, with the tables that you have put in. I mean there are two things, are there not; you want us to realise the importance of the industry?—The importance of it

15706. Certain facts that you are giving us now, together with the table you have put in, would give us all we want to know in that respect. You are stating that the oysters are imported into this country, for instance, and how many are imported. Well, then, I suppose we ought to know the importance and magnitude of this industry, so that no regulations that we impose should injure such industry; I suppose that is your point?—Well, my point is this: The Local Government Board introduced a Bill which was put before a Select Committee of the House of Lords in 1900, and this Bill was defeated. The Bill was altered by the Select Committee in such fashion that in the opinion of the Local Government Board it became unworkable; it was therefore withdrawn. I think if the Commission are about to propose any method of attacking the problem that they should have the industrial side of it before them and also have the views of some of the representative oyster culture people in order that they may see the relative values of the question. I am afraid unless that is done, in so far as efficient legislation is concerned, the matter may be postponed more or less indefinitely again. The problem is becoming a very important one, and it should, I think, be seriously faced.

15707. You mean that we should discuss with these representatives of the industries the measures that we are proposing; do you mean that?—I think that in the first place it would be desirable that the Commission should have before them a representative of each fishery district in England, that is about twelve, and that the Commission should ask such representatives the distribution of shellfish in their area and what steps the Committee have taken or are able to take to prevent the pollution of such shellfish.

15708. That is rather a different thing from what your first proposition is, with regard to the Fishmongers Company and the oyster industry. I understand that to be quite a different point, taking the Fisheries Committees and getting information from those, al they can tell us, each of them about its own area; but as to the general questions on the industry, shall we gain anything more from the Fishmongers Company?—I think that the two representatives I suggest from the Fishmongers Company would sum up the case for the industrial side, and in a relatively impartial manner. Moreover, the Commission will obtain from them an outline of the foreign industry, and this would not be forthcoming from the Fisheries Committees.

THE NATURE OF THE ILLNESS CAUSED BY SHELLFISH.

With regard to the nature of the illness associated with shellfish—that applies to all shellfish. In the first place there are attacks of gastro-enteritis which are probably toxic in nature. I mean, due not to bacteria but to toxins produced by bacteria. Then there is the bacterial infection proper, which also gives rise to a later developing gastro-enteritis, to enteric fever, and to cholera, and, inferentially, to any other water-borne disease; but as to other water-borne diseases, we have as yet no evidence. Then there are cases of dual infection. There is a considerable number of outbreaks, where some of the people who ate oysters or shellfish have been at once seized with attacks of gastro-enteritis. Some of these persons have recovered, some have died, and some have been attacked about a fortnight afterwards with enteric fever. That is to say you apparently get at times a multiple infection which manifests itself in different ways. I take it the Commission will hardly wish me to go into the bacterial aspects of the question. I will only just refer to the fact that Dr. Klein did on one occasion find the typhoid fever bacillus in oysters taken from a highly-polluted source, that he examined other groups of oysters mainly for organisms of sewage origin, *bacillus coli and bacillus enteritidis sporogenes*, but there was nothing to be learned from those examinations as regards proximity to sewers at that time. That was in 1895. Well, then, the experimental work which has been done shows briefly that the bacillus of enteric fever will remain alive in sea-water and in an oyster for a period of eighteen days. That is to say under laboratory conditions. Then with regard to cholera. The cholera vibrio has been recovered from water after fourteen days, and it has been recovered from the oyster up to nine days, but it appears that after four days the morphological aspects of the cholera vibrio are very materially altered and that this alteration appears to be stable, but Dr. Houston would probably tell you more about that than I can.

15709. (*Mr. Power.*) About the enteric fever bacillus. Has that altered in any way, you have not said?—Apparently not.

15710. Nor its physiological effect?—I think as far as the evidence goes, no. Then Professor Herdman and Professor Boyce have also done some work in this direction, and have extended the inquiry by subjecting the oysters which had been infected by the typhoid bacillus to a stream of running water for two or three days. They found that after seven days the oyster frees itself from the typhoid bacillus.

15711. (*Chairman.*) Even from its alimentary canal? —As far as their experiments went. Then, there have been some experiments done in Germany and in France, or rather some observations made, as to the number of organisms in sea-water. I think that is a very important point. Apparently, from the mouth of the sewer seawards the number of organisms diminishes very rapidly indeed according to these experiments.

15712. What experiments are these; who are they by?—Well, one is done by Fischer of Germany, and the other is done by Monod, who was appointed by the French Government to investigate the conditions of oyster culture in France, and to report as to the liability of oyster beds to become fouled by sewage.

15713. Were these total organisms?—Yes, there is no differentiation of the organisms; it is rather of mechanical interest.

15714. This is the examination of sewage outfall into the sea?—Into the sea.

15715. And of the water at different distances from the outfall?—At different places; I can hand in figures about that.

15716. Can you give us the reference to the paper?—I can show you the paper. That diagram represents Kiel Harbour, and the numbers relate to the specimens taken at different states of the tide. But the tendency of these experiments, as far as they go, is to show that the number of micro-organisms diminishes very rapidly indeed, and moreover that the number of organisms on the surface is infinitely greater than at a metre below the surface. That probably means that owing to the different specific gravities of the sea-water and the fresh water, the latter flows on the top of the sea-water and carries with it the sewage.

Then with regard to this matter there is one point which I should like to bring before the Commission, and that is as to the distribution of bacillus coli in nature. I would submit that there is no sufficient information about that subject to justify a general inference with regard to sewage pollution of oysters. For instance, do we know whether the intestinal tract of a fish contains bacillus coli, and do we know whether the intestinal tract of a seagull contains such bacilli or enteritidis sporogenes? Unless we know that we are likely, in dealing with a single batch of oysters which may have been fouled by fish or bird, to draw unjustifiable inferences. The topographical conditions of the layings and their liability to become fouled by sewage must always be had regard to. Topographical considerations are, in my view, the more important, and Dr. Monod, who examined the French oyster beds for the French Government subsequent to the issue of my report, adopted the same standard.

15717. In taking bacillus coli as our test you mean?—Yes.

THE GOVERNMENT OYSTER BILL.

Then with regard to the Bill which was brought before the House of Lords, that Bill proposed to give to County Councils and to County Boroughs the power to prohibit the despatch of oysters to market from certain layings, and it proposed that where beds or layings were contaminated oysters taken therefrom should stay for ten days upon approved layings before they were despatched to market for consumption. That was briefly the summary. With regard to foreign oysters it proposed that on a certificate of the British Consul it should be possible to prohibit the introduction of oysters. The Bill had certain defects, *i.e.*, it had no application to natural oyster beds; it was not suitable to the case of Ireland or Scotland. It did not provide for the registration of oyster laying or ponds, a point, in my view, of considerable importance. Moreover, it did not deal with mussels, cockles, whelks, periwinkles,

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crabs, etc. I think a comprehensive measure should do this. Those, I think, are the main points which I wish to bring before the Commission in the first instance.

15718. (*Colonel Harding.*) Have you any views to lay before the Commission, as to what, in your opinion, would be the best way of dealing with this matter?—Do you mean as regards going further into it as regards evidence?

15719. Well, I gather that you do not think the presence of certain bacilli in the water would necessarily imply sewage contamination, but would you suggest that if there is evidently a sewage outfall, shellfish should not be laid down within a certain distance of it?—Most emphatically. My suggestion with regard to bacillus coli was rather one of academic interest. There is, I think, no doubt that no shellfish should be laid down or taken up from anywhere near to a sewer outfall.

15720. (*Chairman.*) What does "near" mean?—The whole question is a relative one, and there may be a separate law for each river.

15721. (*Mr. Power.*) You mean set of currents, and matters of that kind, run of the tide?—They would have to be considered. If the thing is to be reduced to a question of bacterial sterility, then you would perhaps have to condemn every oyster industry along the coast.

15722. (*Major-General Carey.*) As to existing layings, where they are near sewage outfalls, take either Cleethorpes or Grimsby; would you suggest that these layings should be removed, or that the outfall should be altered?—That is an extremely difficult question to answer in any specific instance, as to whether the sewers or the oysters are to suffer; it depends upon the relative magnitude of the industry and the sewage disposal. There are cases where, for instance, one woman is engaged in the cockle industry, and in order that she may continue to ply her cockle industry with safety to her *clientele*, you could hardly put a large town to the expense of sterilising its sewage.

15723. Sterilising being practically the only way of absolutely preventing possible pollution of the oysters?—Well, it seems to me that the Commission may wish to determine as to how far a fresh water standard is applicable to the mixed estuary. What are the relations between the fauna and flora of an estuary and the typhoid bacillus.

15724. (*Chairman.*) First of all you think that we ought to get this general information from the Fishmongers Company, with regard to the industry generally?—I think so.

15725. As to its importance. And I suppose we shall learn from them also what possible dangers are increased by the amount of interchange which takes place between one station and another?—To some extent. I think you will rather get their views and, having obtained them you will be more likely to be able to frame a measure which will have a good chance of passing into law.

15726. We should consult these persons not only with regard to general information on the industry, but we should also ask their opinion with regard to any measures we might think of recommending?—I think it will be very desirable.

15727. (*Mr. Power.*) We should learn what they were anticipating was to be done?—I think so, yes.

15728. (*Colonel Harding.*) I suppose there is a general acceptance by them of the conclusion that it is inadvisable to have shellfish laid down within short distances of sewer outfalls, and we should ask them therefore what they suggest themselves. Whether there are districts which may be considered to be absolutely free from sewage contamination which would be available for them, and so on. Is that the direction, do you think?—I am afraid you will find their views not quite sound on that matter.

15729. They do not see any objection?—They are very sceptical as to the evidence with regard to the connection between typhoid fever and oysters; that is to say, a certain section of them is. There are many who quite recognise the necessity of taking measures.

15730. (*Chairman.*) We should learn from these, I mean, the difficulties there are in proposing any measures?—The difficulties are really very great. They would at once say, "What are you going to do to prevent an effluent from coming on to our oysters in the future. If there is an oyster laying, and a town springs up, what are you going to do to protect us against this effluent, which they tell us they cannot purify"; that is their position now.

15731. But in the paper that you sent round you spoke of their giving us a general outline of their industries, but you want us to do a great deal more than that, you want us to consult them on the whole question. You think it would be advisable that we should consult them on the whole question?—I think it would be advisable that they should be briefly talked to on the subject. Having seen two or three of these witnesses the remainder will not occupy much time.

15732. (*Colonel Harding.*) Then you do not think that they would accept the statement that there is an obvious danger in having shellfish collected from the immediate neighbourhood of sewer outfalls; you think they would not accept that?—The better educated would, but the others will simply tell you they have eaten shellfish from that locality all their lives and they are perfectly well; that is the line of argument they will adopt.

15733. (*Chairman.*) Then you think we should consult the Sea Fisheries Committees, the twelve of them; you say there are about twelve of them?—There are about twelve of them, I will show you a map here.

15734. Your view is that we should consult these Sea Fishery Committees. They would tell us of the particular cases within their area, I suppose?—They would tell you the distribution of oysters, mussels, and cockles in their area, and then they would tell you what, if any, precautions are taken to prevent pollution.

15735. And what measures they desire should be taken also, possibly?—Yes, the Commission could ask them whether they would have objection to certain measures.

15736. I mean we could consult them, as you propose we should consult the other authorities, on the whole question, with the view of our recommendations being practically useful, and such as would be readily adopted and practically carried out?—I think so.

15737. (*Mr. Stafford.*) Might the Commission have a copy of the Bill promoted in 1900?—I can hand in a copy. I can hand in also a report upon the Oyster Bill.

15738. What are the precise provisions in the Bill with regard to these layings in England; how do you propose to protect them?—The approval or disapproval of oyster layings by the County Councils or by Boroughs.

15739. That is by the Medical Officer of Health of Councils?—Well, that is the inference, yes.

15740. (*Chairman.*) That was a Bill promoted by the Local Government Board, was it?—That was promoted by the Local Government Board.

15741. And withdrawn?—(*Mr. Power.*) Yes, the Committee of the House of Lords altered it by putting the Fisheries Committee in place of the Medical Officer of Health.

15742. (*Mr. Stafford.*) Were County Councils to have absolute discretion then as to where oysters were to be laid?—There was to be an appeal to the Local Government Board.

15743. Had the medical officer of health anything to guide him in the matter as to what was or what was not a proper laying for oysters; would he have anything to guide him?—He could submit the oysters and the water over them to bacteriological examination, he could study the topographical relation of the layings to sewer outfalls, and also the epidemiological aspects of the question.

(*Chairman.*) Will you get copies of the Bill and of the report; I should think the report would be very useful?

(*Secretary.*) Yes.

(*Chairman.*) And circulate those.

15744. (*Mr. Stafford.*) This is the report here, is there a copy of the Bill attached to it?—No, I am afraid there is not a copy of the Bill attached to that.

15745. Have the layings improved very much since you made that report in 1896?—They have in certain places. In others there has been no attempt whatever made to improve. I may mention, for instance, the Penrhyn river in Cornwall. There the oysters are laid down at the mouth of the drains, and they have been laid down there for a very long time. There have been several outbursts of typhoid fever which have been attributed to these oysters.

15746. Have the Local Government Board not been able to bring any pressure upon them?—The Local Government Board has no power whatever. These estuaries are not streams within the meaning of the Rivers Pollution Act unless they are declared to be so after formal inquiry by the Local Government Board. But even were all the shellfish estuaries thus declared it would still be unwise to collect shellfish from the proximity of a sewer or drain outfall, no matter what method of purification was adopted. The Commission might examine the Exmouth papers as to this point.

15747. Has it prevented the sale of oysters to any extent, the fact that you have reported that these oysters have been laid in the neighbourhood of sewers?—At the time of the report it gave rise to considerable excitement and the sale went down by 50 or 60 per cent., but now it is beginning to assume its normal proportions, except for periodical outbursts such as the one of which we have just heard in connection with the Emsworth oysters. I may say that at Leigh, for instance, cockles are treated in such fashion as not to render them free from pollution, but rather to pollute them, and the Medical Officer of Southend seems to think that some of the autumnal rise of enteric fever in Southend is due to the cockles. He has written a very interesting report upon that, and I think the Commission would do well to call him, amongst others, to hear the epidemiological side of the question.

15748. (*Secretary.*) What is his name?—Dr. Nash.

(*Chairman.*) We have this report; he works it out very well, I think.

15749. (*Mr. Stafford.*) Would there not be a difficulty in dealing with the cockles and mussels. Oysters have special layings, but cockles and mussels seem to be distributed over a very large area?—I think it is a comparatively simple matter to deal with the problem up to a certain point. If you hope to deal with it absolutely you may kill the industry and seriously damage all those persons connected with it, but if a reasonable view is taken of it I do not think there are great difficulties.

15750. (*Chairman.*) Is it possible to ascertain in any way what improvements have taken place in these various places that you have reported upon since your report?—I think I can tell you all the improvements which have taken place.

15751. Could you let us have that—Certainly.

15752. What changes have taken place since the time of your report in the way of improvements?—Yes.

15753. (*Colonel Harding.*) Improvements have taken place?—Improvements have gradually taken place. That is to say with regard to oyster layings. With regard to mussels and to cockles, nothing has been done. But my report only touched very briefly upon mussels and cockles.

15754. (*Chairman.*) But you could bring the thing up to date, we should know then exactly what was the condition of these various places with regard to oyster layings, and so on?—I could do that. I may say I am at the present moment writing a report upon the mussel and cockle industry, and upon their relations to sewage pollution.

15755. Could you not put some of that in evidence before us?

15756. (*Mr. Power.*) Is it in print yet?—No, it is in writing; a good lot of it is in writing.

(*Colonel Harding.*) Put an abstract before us; an abstract of your conclusions.

15757. (*Chairman.*) When will you have it ready for going to press?—I am afraid not for some time; there are several other districts which I have to visit.

15758. It is at present incomplete?—Decidedly.

15759. (*Mr. Stafford.*) Could you tell us your general conclusions with regard to the cockle industry, to what extent it spreads enteric fever?—I think it certainly does do so when the cockles are gathered or laid down in the vicinity of pollution. I drew attention to such pollution at Leigh, in my Oyster Report in 1896.

15759* We might have that in evidence without trenching upon the report at all.

(*Chairman.*) That had better be distinctly in evidence. This is only a conference at present between Dr. Bulstrode and the Commission, but I imagine we had better ask Dr. Bulstrode at some time to give us some distinct evidence on those points.

(*Secretary.*) Dr. Bulstrode's suggestion was that he could be called again at a later stage.

(*Mr. Power.*) It would be well to hear him later.

(*Colonel Harding.*) Quite so.

(*Mr. Stafford.*) It is very important.

15760. (*Chairman.*) Then beside fishery people, you think we might call with advantage certain Medical Officers of Health, with reference to specific infection. We have had several before us, you are aware of that?—I am.

15761. But you think there are several others that we ought to ask to give evidence?—I think it is very important for the Commission to arrive at their own conclusions as to the value of the evidence which has been adduced as to the connection between shellfish and enteric fever.

15762. Yes?—And therefore I have set down the names of Medical Officers of Health who have investigated certain outbreaks, and who approach the problem from somewhat different standpoints. I have put down Dr. Niven on the top of my list.

15763. Dr. Niven of Manchester?—Dr. Niven of Manchester. He may be supposed to take the mathematical view of the evidence, and perhaps if you started with him and then finish with others who generalise rather more widely, you would get a comprehensive view of the subject.

15764. But these are people who speak from their experience?—From their experience.

15765. Not only from the mathematical?—All these have endeavoured to work the problem out in their own way.

15766. How many do they amount to?—Well, I have put down here eight, but I can give you many more if you care to have them.

15767. Might we hear the names now?—Dr. Niven, Dr. Thresh.

15768. We have had Dr. Thresh; he has spoken to us rather fully with regard to the Essex outbreak. Yes?—Dr. Robertson of Sheffield.

15769. With regard to Cleethorpes?—With regard to the Cleethorpes oysters. Dr. Nash with regard to Leigh and Southend, Dr. Blamey of Penrhyn with regard to Cornwall oysters, and Dr. Chalmers of Glasgow with regard to an outbreak which was attributed to oysters—the Stirling Ball outbreak. That was rather an interesting outbreak. Dr. Newsholme of Brighton with regard to oyster-borne enteric fever at Brighton from the consumption of Southwick oysters. And then Dr. Kemp of Exmouth with reference to an outburst of typhoid fever caused by the consumption of cockles among Sunday School children in Exeter. Dr. Collingridge of the City of London would, I think furnish the Commission with some valuable evidence.

15770. The Glasgow one which was attributed to oysters proved not to be so?—I believe that after a time several people who went away from this ball and had enteric fever were found not to have had oysters. At first it looked like an outburst of enteric fever due to oysters, but subsequently I think Dr. Chalmers came to the conclusion that the case against oysters was not conclusively established.

15771. Then you wish us to hear it as a case that has failed?—I think a discussion of the case would be instructive.

15772. (*Sir William Ramsay.*) Are we to make up our minds now as to whether or not oysters can be polluted by the sewage effluent; it does not appear to me that that is our business at all?—I think that might be accepted.

15773. I think we should accept that. Why should we hear evidence for or against that; we cannot possibly go into that question; we must accept that the sewage effluents are dangerous to health?—I would suggest that the Commission should ascertain how dangerous.

15774. Do you think there is any need. If there is a single death, that is all we need trouble about. We have got to keep the two apart—shellfish and sewage effluent. I suppose we shall not hear any evidence that the effluents are food for the shellfish?

15775. (*Chairman.*) But you see Dr. Bulstrode told us that some of the representatives of the oyster industry deny all these alleged cases of illness through

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consumption of shellfish: is not that so?—Well, very largely they deny them, but I do not think there is much opportunity of convincing many of them. At the same time, if it is proposed to do anything which is to be of use and to pass into law it is most essential that every side should be considered. It would have more weight if the Commission satisfied themselves that there was this real danger.

15776. (*Chairman.*) That was my point, that if these witnesses pooh-pooh them we ought to have evidence before us to show that there is reality in the statement?—Well, I may say, sir, the House of Lords Committee accepted the position straight away. They said they did not wish to hear any evidence—"we accept the fact that shellfish may be instrumental in disseminating disease"—and they proceeded to the administrative side at once.

15777. (*Colonel Harding.*) Then there is abounding evidence, is there, that shellfish do carry forward pathogenic germs?—I think so.

15778. (*Chairman.*) Oysters, cockles?—Oysters, cockles, and mussels.

15779. Mussels; what is the evidence with regard to mussels?—Well, there are outbreaks of typhoid fever which have been attributed to mussels.

15780. And whelks?—No cases alleged to have been caused by whelks have come beneath our observations, but whelks so far as I have seen are absolutely boiled. I have timed the whelk-boiling in Norfolk, and certainly the process is one of absolute boiling. I see, however, that Dr. Newsholme attributes certain enteric fever in Brighton to whelks, so that it would be well that the Commission should ascertain as to how far the several processes employed suffice to kill the bacillus of enteric fever. With regard to cockles it is not always or perhaps generally so, although in the case of cockles I have seen the cockles in the pan over the fire for 25 minutes, and during the larger part of this time the cockles in the lower portion of the cauldron have been in water which was certainly boiling. I should, however, be glad to see the Commission making some experiments with regard to the effect of the several methods adopted upon the bacteria held between the shells, or in the branchiæ or intestines of the several molluscs in question.

15781. And may we take this for granted that on the one hand cases of typhoid fever have been traced to oysters and to other shellfish, and also that the reason why these shellfish were themselves the means of conveying typhoid fever was due to their being placed in proximity to sewage discharge?—I think that must be accepted.

15782. We might take both these for granted?—I think so.

15783. Then we do not want to examine these Officers of Health.

15784. (*Mr. Power.*) Only as to the dimensions of the fever referred to that cause?—I think it is rather important that the Commission should know what a large number of people there are depending on this industry round the coast.

15785. (*Chairman.*) That we learn in the first instance?—Yes, quite.

15786. We are now talking about the Officers of Health. It is admitted by the House of Lords that typhoid fever is caused by shellfish, and it is also admitted that the reason why the shellfish cause typhoid fever is because they are placed, or found, in the proximity of sewage outfalls.

15787. (*Mr. Stafford.*) But do we not want to know the extent of it?—That is the point.

15788. (*Sir William Ramsay.*) Why? Does it matter whether a hundred people die a year?—If one dies that is sufficient.

(*Mr. Stafford.*) I think it matters immensely.

(*Chairman.*) Your justification for any measures will be the gravity of the danger against which you are contending.

(*Mr. Stafford.*) Quite so.

15789. (*Chairman.*) We do not measure it by the number of Officers of Health we call before us; can we not get some other measure of the gravity; would not one, or two, or six state what is the gravity: give us evidence of what is the gravity?—I can give a synopsis of the outbreaks which have occurred and a general criticism of the evidence, but at the same time perhaps it would be better if such criticism came from a less official source.

15790. That is the point of consulting these Officers of Health to get a clear idea of the magnitude of the evil we have to combat.

(*Mr. Stafford.*) Quite so.

(*Major-General Carey.*) And of course it is merely an expression of opinion on their part, they cannot trace it beyond certain of the facts.

15791. (*Mr. Power.*) They speak of the amount of fever in their districts referable to shellfish, and the amount of fever due to other causes?—Quite so. I think the evidence with regard to the Connecticut outbreak, an account of which is contained in the Local Government Board's Oyster Report, and which I have no doubt the Commission has read, is quite satisfactory epidemiologically. You cannot actually prove a case of this nature, but you can prove very little epidemiologically. It is a matter of inference based upon circumstantial evidence, a form of evidence which is at times regarded as justifying capital punishment.

15792. (*Mr. Stafford.*) What form of scientific investigation do you suggest the Commission should make, or do you suggest them to make any?—I think it would be extremely instructive if the Commission could ascertain the distribution of bacillus coli.

15793. In sea-water?—Well, in sea water and in the animal kingdom generally. I think it would not only be of use to this subject, but it would have a very general application.

(*Chairman.*) Is not that rather a tall order?

(*Sir William Ramsay.*) We are restricted I think.

15794. (*Chairman.*) Officers are engaged doing that under our work?—I know, some of the———

15795. It is only taking a small portion of the universe at present.

15796. (*Major-General Carey.*) Certain classes of oysters; oysters from Holland, we will say, are not subject to any control whatever, are they; do they come direct to market?—Those Dutch oysters are, I believe, subject to a certain form of Government control, but it might be well if the Commission satisfied itself as to how far such control is efficient.

15797. They are subject to some control?—Yes.

15798. In England we have no control?—None.

15799. We take them just as we find them?—Yes. I would suggest that the question of calling the Medical Officers of Health may be left over till the Commission have received evidence on other points, and heard the views of the fishery people.

15800. (*Colonel Harding.*) You have doubts as to whether the presence of a bacillus coli is conclusive as to the source of sewage pollution being connected with that particular bed, but does the same doubt exist in your mind with regard to other germs, such as the bacillus of typhoid and the cholera vibrio?—Not at all. My point is merely this: I do not think the distribution of the bacillus coli has been sufficiently worked out to allow a dogmatic statement with regard to one given batch of oysters. If the bacillus coli is to be found normally in the intestines of the fish or of the seagull there is, it seems to me, likely to be a fallacy in inferring human sewage pollution from the fact of the presence of the bacilli of this colon group in a given batch of oysters, and the difficulty is not entirely got over by setting up a numerical standard.

15801. (*Chairman.*) The point is this, that it has been assumed, you see, that if the bacillus coli is found in the oyster, the oyster has been subject to sewage contamination?—That is so.

15802. And you think that before that is accepted we should have some larger knowledge of the general distribution of the bacillus coli?—Yes.

15803. (*Mr. Stafford.*) Is not that accepted with regard to fresh water; with all drinking waters the presence of the bacillus coli absolutely is?—I think so, but at the same time it would surely help us if we knew a little more of the distribution of the bacillus. We know that the number has relation, for instance, to the sewage pollution in relation to a given sewer, but I think we hardly know enough of it when we get outside the sphere of influence of sewers altogether.

(*Dr. Houston.*) Bacteriologists usually cover any accidental contamination by not judging by the mere presence of bacillus coli but by its relative abundance.

(*Chairman.*) Quite so.

(*Dr. Houston.*) Most bacteriologists, simply because they found one B. coli in an oyster, would not care to

say that it was certainly due to sewage pollution, but if they found a large number it would be a different thing altogether.

(*Chairman.*) I rather gathered, from the few reports that I have read, that the mere detection of the bacillus coli in the oyster was the argument used that there had been sewage contamination.

15804. (*Dr. Houston.*) I do not accept that?—(*Dr. Bulstrode.*) I shall be glad to supply evidence in support of the statement that this argument has been used by some bacteriologists, and this is why I ask for more light upon this subject.

(*Chairman.*) I think, for instance there, is the report of the Exmouth and Exeter; one man, I think the bacteriologist, a man named Turner, I do not know him at Exeter, simply says that he found bacillus coli, but he does not say how many he found.

15805. (*Dr. Houston.*) Of course that is to some extent a misleading statement?—That is what I wished to guard myself from.

15806. (*Colonel Harding.*) But the more dangerous germs have also been found, have they not, in oysters?—Very rarely. They have been found, and certainly they are liable to be found; I mean no one would, I think, deny that the bacillus of typhoid fever has access to oysters at times. But the bacillus has only very rarely been discovered in outbreaks of enteric fever, which have, in all probability, been due to specifically infected water.

15807. (*Chairman.*) The search for the typhoid bacillus is a little difficult, is it not?—Yes, it is very difficult.

15808. Are there many cases in which it has been found?—About four cases only.

15809. There is the Jenner Institute one?—That is a recent occurrence.

15810. Do you know that?

15811. (*Dr. Houston.*) Yes; I think they found it not in the same batch that was supposed to have caused the typhoid, but in one that they got immediately afterwards?—Yes, I think that was so.

(*Mr. Power.*) Do you know the evidence on which it was identified?

(*Dr. Houston.*) No, they have not, I believe, published the details yet.

(*Mr. Power.*) Then we have nothing but the bare statement that they did find it.

(*Chairman.*) Only that there is some statement as to reactions.

(*Dr. Houston.*) I do not think they have ever produced any further evidence of the characters of the organism in question. At least I have not seen it.

15812. (*Chairman.*) Your observations were rather tending that we should be very careful in our deductions as to bacteriological evidence with regard to sewage contamination; is not that so?—When the oysters are taken from a position which topographically is remote from sewage pollution.

15813. Well, then do you think that we ought to go into all these cases of oyster laying, and to see with regard to each one of those what evidence there is?—I am afraid that is impracticable.

15814. That is impracticable I suppose. Well, what could we do; are there certain illustrative cases?—I would suggest that the Commission might care to visit places like Emsworth and Flushing, where they will see the relation of the sewers to the outfalls, and again that they should also visit a place like the Pyfleet in the Colne, where they will see the magnitude of the problem, and recognise the difficulty of applying the drinking water standard to it. I suggest that the Commission should see each place both at high and at low water.

15815. I was thinking rather not of going to visit simply, but of taking evidence, or getting information concerning them. It is very obvious, you see, we could not examine or take evidence with regard to all these places. Are there any that we could select as typical ones?—I can furnish the Commission with what I regard as typical cases. I will give to the Secretary three or four typical cases

15816. Typical in two directions?—Typical in two directions.

15817. In the good direction, and the bad direction?—Quite. It would be most interesting to see them worked out bacteriologically.

15818. This bacteriological examination in those cases will be rather an extensive one, will it not?—If it is carried over all states of the tide perhaps.

15819. It would be very unsatisfactory, for instance, simply to take two samples, one on the ebb, and one on the flood —Yes

15820. And you would have to take samples at different depths, I suppose?—That was rather in relation to this French work as to the number of micro-organisms; that was rather another question.

15821. What do you think about that, Dr. Houston? Does not that open up rather a large amount of work?

15822. (*Dr. Houston.*) It depends if you eliminate looking for typhoid, it lessens it very much?—That is not necessary at all.

15823. If you simply search for bacillus coli.

(*Chairman.*) Relative quantity of bacillus coli.

(*Dr. Houston.*) Yes, I do not think it need involve a very long research, and it would give useful information.

(*Chairman.*) What is our knowledge of bacteriology of brackish water, of estuary water?

(*Dr. Houston.*) Oh, very little indeed, almost none in this country.

(*Chairman.*) Has it been done anywhere?

(*Dr Houston.*) It has been done abroad.

(*Chairman.*) Where?

15824 (*Dr. Houston.*) Fischer has done a lot of work?—Fischer I am referring to

15825. Quite, and several others; I cannot give you the names just now, but they have done a great deal of work.

(*Mr. Power.*) But you would have to take more than one micro-organism, more than bacillus coli, as an index.

(*Dr. Houston.*) Oh yes, I think you would have to take bacillus coli and enteritidis and possibly cocci. That is a difficult test.

(*Chairman.*) Did Fischer find any organisms characteristic of estuary water, brackish estuary water.

(*Dr. Houston.*) As apart from the sea-water organisms

(*Chairman.*) Yes.

(*Dr. Houston.*) Not that I know of.

(*Chairman.*) Because you would have to deal first of all with what was the natural condition of the estuary and how for that pollution of fauna had been modified by the sewage discharge.

15826 (*Dr. Houston.*) Yes?—The vitality of the organisms of typhoid fever and cholera is very important in the sea, but I suppose that is difficult to work out.

15827. (*Dr. Houston.*) Everyone gets different results?—Probably a different result would obtain in each estuary, I take it.

15828. (*Chairman.*) I was very much struck with the bacteriological fauna of Venice; it is very remarkable?—Of Venice?

(*Mr Power.*) Do you mean at high tide?

(*Chairman.*) The remarkable diminution of a large number of organisms there.

(*Mr. Power.*) At the high water.

15829. (*Chairman.*) At the high water. I mean in some of the *cul de sacs* of the little canals there; the *cul de sac* of St. Mark, for example; one always thought that was the most filthy place of the whole of Venice. The bacterial flora of that is much less than down the Thames?—At high tide as well as at low tide.

15830. At high tide; I think there are results at low tide also. Of course the tide there is about a couple of feet?—Yes.

15831. But in these, one thought it would be teeming with organisms. The flora is distinctly less than that of the Thames.

(*Dr Houston.*) Dr. Lorraine Smith told us that cockles collected from a pool where there was no sewage pollution did not contain coli and bacillus enteritidis sporogenes, or at all events they were relatively absent, and that the cockles collected from a source which was polluted with sewage contained great numbers, and that the

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distinction was very marked, so that any chance contamination, I think, would be more than covered by the wide distinction between cockles or shellfish collected from a polluted area, and others collected from a non-polluted area.

(*Mr. Power.*) But we found when testing the oyster that although we took oysters from contaminated layings, they did not always contain bacillus coli.

(*Dr. Houston.*) Yes.

15832. (*Colonel Harding.*) Has it been found that the neighbourhood of a sewer outfall brings about any visible kind of disease in the oysters and shellfish?—No.

15833. That is to say, putting it in another way, are germs which are pathogenic to the human body in any way pathogenic to the oyster, or are they innocuous?—As far as we know, they are not injurious to the oyster, the oyster which has been experimented upon in tanks with the typhoid fever bacillus has presented quite a healthy appearance. At the same time it is very doubtful whether oysters would survive quite in a sewer. There is no evidence as to that. They certainly flourish and fatten, quite within a few yards of a sewer.

15834. Then the chief danger is in connection with the oyster, which is eaten to a large extent uncooked. As regards mussels and cockles they are generally cooked —I am afraid only insufficiently cooked.

15835. (*Chairman.*) The evidence is that they are not? —Not sufficiently cooked. The cockle is lowered for a short time into hot water, and on bacteriological examination, the bacteria are found still alive. Is not that so? I shall be prepared to give some evidence at a later period as to the method of preparing cockles for market in different parts of England.

15836. As shown in the photographs they are simply dipped down into the boiling water for a short time?—In that case they are dipped down for five minutes into boiling water, but those photographs related to whelks. The method is precisely the same in many places for cockles.

15837. (*Mr. Power.*) They are dipped in a net in a mass?—They are dipped in a net, yes.

15838. (*Colonel Harding.*) But I think there are some observations that in the so-called cooked cockle there were still bacteria present?—Yes, especially in the upper layers of the cockles. They are put into a cauldron; the lower portion of the cockles in this cauldron is boiling, but the cockles in the top layer only open by the passing steam; directly the top cockles open the cauldron is emptied so that the top ones would not be sterilized, but the bottom would.

15839–40. (*Dr. Houston.*) You would have to have a temperature of 58 degrees Centigrade for five minutes to kill the enteric fever bacillus.

(*Chairman.*) Something depends upon the medium; I suppose the liquor of the cockles might perhaps preserve them for a little as well.

(*Dr. Houston.*) Yes, it might.

(*Chairman.*) In the distilled water they would be killed in a much shorter time, or shorter than in their own liquor. The cockle possibly is a culture medium for the enteric fever bacillus.

(*Colonel Harding.*) I feel we must not go into this matter too deeply. It becomes a very big matter indeed. We had better assimilate what has been found before by our predecessors in various directions.

(*Chairman.*) I think so.

(*Sir William Ramsay.*) I really do not see how we can embark in another large inquiry, it would mean a very large inquiry.

(*Chairman.*) On the other hand I think you know we must report on it.

(*Colonel Harding.*) We are bound to do that.

(*Chairman.*) And we cannot report upon it without having made ourselves thoroughly acquainted with it.

(*Colonel Harding.*) We had better grasp what has been done before; if in any particular specific direction at would not involve any large labours, we could get additional information.

(*Major-General Carey.*) If we could get information as to the pollution of oysters and possible injury.

(*Chairman.*) I take it we must report upon it, and if we must report upon it we must grasp the problem before we can report.

(*Mr. Stafford.*) I do not see how you can possibly report unless you investigate further into it.

(*Chairman.*) No; no more do I.

(*Chairman.*) The Salmon Fisheries Committee's Report, you see, takes it for granted that we are going to do this.

(*Mr. Stafford.*) How can we possibly suggest remedies unless we investigate fully the question?

(*Colonel Harding.*) We ought to investigate to an important extent; it must follow on the work which we have already in hand; it must not interfere with it.

(*Chairman.*) Quite so. Oh, no, we must not interfere with it, I think. Are there any other things you would like to bring before us?—I think not at this stage. If you propose to call me again at a later date I should be prepared to give evidence:—

(*a*) As to the occurrence of almost wanton pollution on the part of those who are preparing shellfish for market, and as to the comparatively simple procedure which would do away with such crude pollution. I can submit maps to the Commission illustrating these points.

(*b*) As to the merits and defects of the Oyster Bill submitted to the House of Lords.

(*c*) As to the regulations or bye-laws which might, I think, be applied without much difficulty to the several shellfish industries not only in respect of natural and artificial beds but also in the storage of shellfish in shops, etc.

N.B.—The recent outbreak of enteric fever at Winchester, Southampton and Portsmouth, which has been attributed to the consumption of oysters from Emsworth, has materially modified the position. The oyster merchants have now accepted the situation, and they are now eager for legislation.

H. T. B

12 January 1903.

APPENDIX A.

MEMORANDUM by Dr. *Bulstrode* in connection with the Oyster Bill, 1900.

In anticipation of the application of the Oyster Bill to Ireland and to Scotland, I have thought that a few notes (obtained from the last Report of the Inspectors of Irish and Scotch Fisheries) on the extent and distribution of the oyster industry in Ireland and Scotland might perhaps be helpful. I propose, too, to add a few words as to mussels, cockles, and periwinkles.

IRELAND.

I have no personal knowledge of the Irish Fisheries.

According to the replies from the Irish coastguards, the public oyster beds are distributed at intervals all round the Irish coast.

Commencing with the Wicklow coastguard district, and travelling south, we find beds off Arklow and Rooney Point; in the Wexford district off Rosslare Point (at the mouth of Wexford Harbour); in the Waterford district, between Creadon Head and Ballyhack (*i.e.*, in Waterford Harbour); in the Queenstown district off Horse Head, Carrigaline and Passage West; in the Skibbereen district, in the River Ilen; in the Valentia district, in the Kenmare River (between Dinnirl Island and Kenmare Pier); in the Ballyheigen district at Spa (in Tralee Bay), and between Taebet and Mount Trenchard, and in Ballylongford Bay, in the Seafield district in Poulnaskerry and Clonderlaw Bay, and off Mayen; in the Galway district, in Kinvarra Bay, at Arran Bank, and in Tyrone Bay; in Clifdon district, in Ballynakill Bay, and between Inisharry and Bruzell; in Belmullet district, off Cleggan Islands; in Rathmullan district, from Burt to Manorcunningham, and Fortstewart to Rathmullen; in Moville district, in Lough Foyle; in Carrickfergus district, in Belfast Lough; in the Strangford district, in Strangford Lough, and off Ballyquintin Point; in Dundalk district, in Carlingford Lough.

It will thus be seen that the *public* beds are fairly well distributed around the Irish littoral. It does not seem, if we may judge by the report, that these public beds are altogether in a thriving condition. The beds at Arklow are, however, stated to be "good and clean," and those in the Kenmare River are reported to be in a "good healthy state." In the Galway district the stock is good, as also is this at Moville and certain other places. Some spatting was noticed in several of the beds in 1897.

On these public beds there were, during 1897, 253 boats engaged, and in connection with the industry of these same boats 784 men were employed.

A total number of 13,147 "hundreds" of oysters were taken during the season.

In the main, the oysters from these beds are consumed locally, but considerable numbers are sent to Dublin and Belfast. The total value of the oysters sold from these public beds during 1897 was £4,031.

In addition, however, to the public beds, there are around the Irish coast sundry private beds, or, perhaps, it would be more proper to speak of them as "layings," which are apparently licensed in much the same fashion as are certain fisheries in England and Wales, after local inquiry has been held by an Inspector of the Board of Trade.

At the date when the 1897 annual report on the Irish Fisheries was compiled there were sixty licences to plant oysters in force, and these "layings" were situated in the counties of Wicklow, Cork (Cork Harbour, Roaring Water Bay, etc.), Kerry (Rivers Kenmare and Shannon), Galway (Mannin Ardbear and Galway Bays), Mayo (Clew and Killala Bays), Sligo (Sligo Bay and thereabouts), Donegal (Lough Swilly), Lough (Carlingford Lough).

On these "layings" a considerable number of oysters, "native" and foreign, were laid down and taken up. For instance, on the Lough Matron beds 100,000 "natives" and 7,000 "Americans" were laid down in 1897. In the Owenboy River 6,000 Brittany oysters were laid down.

In the Kenmare River 100,000 French and 150,000 "natives" were taken up from one laying, and 350,000 French laid down in another. So, too, all round the coast energy is being displayed in connection with the oyster industry, and it will be gathered that the public beds form but a portion of the total.

The Inspector of Fisheries reports that during 1897 there were lifted from the private layings 17,881 hundreds of oysters, valued at £4,160. It may be added, however, that these figures are probably below the actual facts.

Private beds - - - - - -	£4,163
Public beds - - - - - -	4,031
	£8,194

It is not unlikely that oysters from the Irish private beds will in an increasing degree find their way into the English markets.

The distribution of the oyster beds and layings in Ireland is therefore so general that administrative control of the layings, etc., such as is contemplated, would have wide application.

Mussels.

Mussels are found extensively around the coast of Ireland, and they are in the main gathered for export to London, Manchester, Liverpool, Leeds, Bristol, Glasgow, and other large towns.

During 1897, out of 2,539¼ tons gathered, as many as 2,489¼ tons were exported. There were employed in the mussel industry of Ireland 669 people, and the value of the mussels collected was £2,595.

It is clear, therefore, that a considerable quantity of mussels from Ireland is imported into England and Scotland for human consumption.

Cockles.

Nearly all cockles which are gathered are for sale locally, but during 1897 2,500 gallons were imported from Waterford to Liverpool. 66,367 gallons were sold locally; 258 were engaged in pickling cockles, and the total value of all cockles sold was estimated at £2,367.

Periwinkles.

Collected all round the Irish Coast and almost wholly exported to Billingsgate, Liverpool, Manchester, Glasgow, etc.

During 1897 1,546¼ tons were collected for export, and only 46½ for local sale. The total value of those collected was £6,076, and 4,388 were employed in the industry.

SCOTLAND.

Oysters.

The information to be derived from the Annual Report of the Fishery Board for Scotland on the subject of the oyster industry of Scotland isnot so concise as is that to be obtained from the Reports of the Inspectors of Irish Fisheries as to the oyster industry of Ireland.

It would seem, however, that in Scotland the production of oysters is limited on the East Coast to the Firth of Forth. The best oysters in the Firth are said to be, or to have been, procured on the rocky ground opposite Portobello, and at Preston Pans, where the "Pandore" oysters are obtained. On the West Coast the oyster supply is almost wholly from West Loch Tarbert in Argyleshire and from Loch Ryan in Wigtonshire.

During 1897 there were landed on the East Coast at Leith 97 hundreds of oysters; on the West Coast at Inverary and at Ballantrae, 3,912 hundreds; and at Orkney and Shetland, 7 hundreds; making in all a total of 4,016 hundreds, as against a total of 2,886 hundreds for the previous year. The value of the 1897 yield was estimated at £1,614.

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Mussels.

There are numerous mussel beds or "scalps" around the coast of Scotland, and the Scotch Fishery Board have recently, under the provisions of Section 11 of the Sea Fisheries Regulation (Scotland) Act, 1895, published a list of the beds in question.

The returns as to the mussels landed during 1897 show an increase on those for 1896, but the price fetched was not so large. This falling off in price is thought by some to be the result of the competition resulting from the impartation of these molluscs from Holland and Ireland.

During 1897 280,976 cwts. of mussels, valued at £14,362, were taken in Scotland.

Whelks and Cockles.

It may be noted that a very important trade in whelks and cockles is carried on between the West Coast districts of Scotland and the English markets.

During 1897 nearly 33,500 cwts. of whelks, cockles, and limpets (these latter principally for bait) were gathered. The cockles are obtained principally from the Barra Sands, the whelks in the Ballantrae and Port William districts.

H. Timbrell Bulstrode.

FIFTY-FIFTH DAY.

Tuesday, 27th January 1903.

PRESENT:

Colonel T. W. HARDING, J.P., in the Chair.

Sir WILLIAM RAMSAY, K.C.B., F.R.S.
Major-General C. PHIPPS CAREY, C.B., R.E.

Mr. W. H. POWER, C.B., F.R.S.

F. J. WILLIS, *Secretary.*

ALSO PRESENT:

Dr. A. C. HOUSTON.
Dr. GEORGE McGOWAN.

Dr. BULSTRODE.

Mr. PHILIPS, called; and Examined.

Mr. Philips. 27 Jan. 1903.

15841. (*Chairman.*) You are Master of the Brewers' Company, and a director in Watney, Coombe, Reid, and Company, Limited?—Yes.

15842. And you have been good enough to give us a number of answers to suggested questions that we put to you. In coming before us to-day, you not only represent the firm with which you are connected, but an association of brewers?—Yes.

15843. Extending how far over the country?—Mostly throughout England and Wales. The Brewers' Company in London, of which I am Master, comprises the London brewers only; besides that, I was asked at the same time to give in my evidence on behalf of the Country Brewers' Society, and that is very extensive.

15844. Does that include, for instance, the Yorkshire brewers?—Yes.

15845. And the Burton brewers?—Yes, some of them.

15846. Clearly, the position is different where a large number of breweries are concentrated within a small limit of space than where they are just spread about in a large city as they are in London?—That is quite true, and applies more to Burton than anywhere else. In Burton they have had to make special arrangements, because it has more breweries than any other industry.

15847. Then you agree that where there is a great concentration of one industry like that it might give rise to special circumstances, which must be considered quite apart?—Yes.

15848. Speaking now more generally, in the cases of brewers in the midst of communities where there are other trades, I understand that you think that the condition of the law in regard to the reception of your trade effluents into the sewers is not satisfactory?—Yes; I think it needs to be better defined.

15849. Will you state to the Commission exactly the points upon which you think the law should be altered?—Well, I think that brewers should have facilities, as I have said, for getting rid of their trade effluents by means of the public sewers. That is not quite defined now by law.

15850. Tell us, will you, what is the character generally of the volume of brewery refuse; is the volume a large one?—Yes, it is large.

15851. What does it consist of?—More of water than of anything else.

15851a. (*Sir William Ramsay.*) Is that water warm?—Yes.

15852. Is it above 110 degrees Fahrenheit?—No, it is kept below. It would be more convenient to brewers to be allowed to place it in over 110 degrees Fahrenheit, but that has already been prevented by law. There are special arrangements in most breweries to keep it down to that degree of heat.

15853. (*Chairman.*) There are many suspended solids in the effluents, are there not?—Yes, where not previously removed.

15854. And those you have found it, probably, quite easy to keep back?—Yes, quite.

15855. And what you think should be received into the sewers is more or less clarified effluent?—Yes; it is the washings more than anything else.

15856. What is its chemical character—the clarified effluent?—Its chemical character is not detrimental to the treatment of sewage, so far as I can learn.

15857. (*Sir William Ramsay.*) There are no strong acids?—There are no acids at all where they have the breweries.

15858. (*Chairman.*) You think that the effluents are such as may be received into sewers, except where the volume is very large?—Yes.

15859. Without seriously affecting the treatment of the combined sewage?—Certainly; yes.

15860. Then what is your difficulty with the condition of the law?—Local authorities have made bye-laws, whether rightly or wrongly. In some instances, under their bye-laws, they have refused to take refuse or any sewage from a brewery.

15861. Any effluent at all?—Yes, anything at all.

15862. And probably not only refuse to take those trade effluents, but may be other trade effluents also?—No doubt, yes.

15863. Then do you suggest to us that the law should be altered so as to compel local authorities to take all trade effluents?—All those that can be dealt with in which there are no acids and that would not interfere with the dealing with their sewage afterwards with regard to land for manurial purposes.

15864. You evidently foresee that local authorities must protect themselves by having power to make bye-laws?—Yes, but my suggestion is that there should be some authority to which there may be some appeal which should have nothing to do with the local authorities.

15865. Some power of appeal?—Yes, there is no power of appeal from the local authority's bye-laws.

15866. But what is the particular alteration in the law that you suggest?—It should not be difficult to define those manufactories for which preventative bye-laws are necessary. I submit that so far as breweries are concerned, they are not necessary.

15867. (*Sir William Ramsay.*) But you would, of course, agree that the brewery refuse should be delivered regularly and not in rushes?—I quite agree with that, that is very easily arranged by a main which can only discharge a certain amount in a certain time.

15868. Then again, the mere increase of volume of the effluent means further expense in dealing with it. Do you think it would be fair to tax the brewers specially because they contribute a very large volume of the sewage, compared to householders, I mean?—Yes, I think that is fair, having regard to the amount which they pay, as compared with other ratepayers. For instance, if a brewery is the only industry in that particular part, and pays very largely towards the rates, due regard ought to be had to what the brewery business pays, and I think that it should contribute something further if it is found that the refuse creates that further expenditure.

15869. (*Chairman.*) I gather from your answers to Sir William Ramsay that you would be ready to concede, would you not, that it is impossible to legislate to suit all cases, and that these matters must eventually be for mutual arrangement between the authority and

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the manufacturer, and with power to appeal to some outside court?—Yes, as long as they had power of appeal, I think they should quite concede that.

15870. But there probably is a difficulty now because some local authorities seem to consider that there is an obligation upon them to receive effluents and others do not?—Yes.

15871. You think that there should be some more clear application of the law?—Certainly; yes.

15872. But if you threw upon local authorities the onus of showing why they should not receive an effluent into their sewers you would concede to them the power to make bye-laws?—Yes, as long as there was some appeal from them. For instance, a local authority, in managing their affairs, might say: We can do this with less expense if we simply say we will not take any refuse or sewage from this brewery, but that is not a good reason, I submit. But they need not give any reason at present; they may say that among themselves.

15873. As to the Court of Appeal that you would suggest, where there are Rivers Boards dealing with a watershed, would you consider it right to appeal in the first instance to such a Rivers Board?—Yes, I should; but I think there should be a separately constituted tribunal besides the Rivers Board.

15874. A central tribunal?—Yes, what I should almost call a Sewage Board, if I might suggest it, rather than a Rivers Board only.

15875. You may have seen that in the interim report of this Commission a suggestion was made about a central body, which would deal with all these questions of river pollution?—Yes, I noticed that.

15876. Is that the kind of Board in which you would have confidence?—If it was called a Sewage Board I should have liked it better. I should have had more confidence in it.

15877. But apart from the name, what you want is a central independent Board?—Yes, an independent Board; that would be quite satisfactory.

15878. In many cases the local Rivers Board might settle the matter, subject always to this further appeal?—Yes; so many local people are on the local Rivers Board, it comes to be constituted the same as the local authority if you are not careful, which is dangerous.

15879. Still, I gather from your former answer that you think that, as an appeal in the first instance, the case might go before the Rivers Board, subject to a final appeal to a central Board?—Yes, certainly.

15880. Is there any point which you would like to put before the Commission, except those which have arisen from the questions which I have put to you? I see from your statement that it is rare that you draw water from the streams?—Yes.

15881. You probably draw water from wells?—Yes, nearly always, and as far as possible.

15882. What is the reason of that; is it because of the special quality or purity of water required that it is drawn from wells?—The purity of the water taken from the wells. It is necessary for brewing. The water from the streams is merely used for cooling purposes.

15883. The difficulties arising from riparian rights do not generally affect brewers?—No; this would not affect the brewers very much, and in cases where they do—I believe there are some cases in the country where breweries take waters out of the streams for cooling purposes—that water would be returned to the stream, and it makes no difference whatever.

15884. You mean that the process of cooling or condensing requires that water be taken from the streams?—Yes, when there are streams; there are a few here in Yorkshire, and they use them for cooling.

15885. You think it is quite possible to keep such waste waters separate from the really polluted waste waters?—They should be kept separate and returned to the streams; no harm is done then to riparian owners.

15886. Have you any suggestion to make to us in these cases; where a large number of brewers are established in a small area, as, for instance, at Burton, and so on a smaller scale at Tadcaster in Yorkshire, where there are five or six large breweries; do you think that in such cases they should combine together to treat their effluents, or that they should make a special payment to the authority?—I think they should make special payments to the authorities. The authorities are best able to deal with the question, because they have greater powers, and special payment is probably necessary by all the breweries.

15887. The special payment, you think, is warranted in that case, because there are others in the district who are paying rates who do not cause any special expense to the authority?—Yes.

15888. In these cases you think it would be fair and right to charge manufacturers who provide a difficult effluent to be treated with the special cost of treating it?—Yes, that is so, as long as the local authority would do it.

15889. (*Major-General Carey.*) You say that there are no acids in the brewery refuse which would have any deleterious effect on the structure of sewers, or would not prejudicially affect the sewage matter on its application to land. Why is it necessary to use so much lime in treating the brewery refuse at Burton if there are no acids in the refuse?—To counteract decay and render the effluent of greater manurial value.

15890. Well, I do not know. Is it not to neutralise the effect of the acid in the refuse?—May I say this, that where breweries, so many, are combined, as they are at Burton, it is difficult to get rid of their solid yeast. I propose in my scheme to keep out solid yeast.

15891. Have you any evidence in support of that general statement that brewery refuse does not prejudicially affect land or the application to land, or interfere with bacterial life?—There is no evidence to the contrary, is there?

15892. I mean in great brewery centres—Burton, Lichfield, and other places—where they are spending very large sums annually in treating brewery refuse, they would hardly support that statement, would they?—I think so. Of course, brewery refuse has manurial value, especially yeast. You see they have not been able to sell it to much advantage, that it has not been used yet for manure. They have disposed of it, as a rule, to Germans for German yeast.

15893. Then, as to the volume of brewery refuse which has to be taken into the sewers, assuming that facilities were given, I suppose that if the sewers were not large enough to take the refuse you would not suggest that they would be enlarged for the purpose?—I should.

15894. In works already existing you think that the main sewer should be taken up and made large enough to take the brewery refuse in?—Yes; I think it should be equal to what it has to do if we have to pay sewage rates.

15895. And in that case would you be prepared to pay a special rate for the convenience of having it taken in?—Yes, taking into consideration what we already pay; due regard being had to that.

15896. It would be a serious thing, of course, to have to take up an outfall sewer and enlarge it for the special purpose of taking trade refuse?—Yes, still it should be taken in hand.

15897. The local authority would certainly say, "We must be compensated for that"?—Yes, I think so, more or less. In my scheme I have provided for that. It should be done somehow or other.

15898. (*Chairman.*) There is no other point that you want to bring before us?—No, I do not think there is anything else besides what I have mentioned in my statement.

15899. We thank you very much for your attendance to-day and the evidence you have given in regard to your special trade?—Thank you.

Mr. H. H. Waller, Mr. R. B. Emsley and Mr. W. B. Pindar.

Mr. H. H. WALLER, Vice-President of the West Riding Urban and Rural District Councils' Association; Mr. ROBERT B. EMSLEY, Solicitor; and Mr. WALTER B. PINDAR, Secretary to the same Association, called; and Examined.

(*Mr. Waller.*) I am a member of the Greetland Urban District Council, and I am also a Vice-President of the West Riding of Yorkshire District Councils' Association, and on behalf of the latter body I have been appointed to give evidence.

The association is entirely confined to the West

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Riding of Yorkshire, and has a membership of 74 councils, including all the largest, both urban and rural. There are a very large number of mills and factories in the West Riding, and an equitable settlement of this question affects them very closely.

The association which I represent convened a conference on 27th May, 1902, not confined to its own members, but open to all district councils in the West Riding. One of the subjects set down for discussion at this conference was the question of admitting trade effluents into the public sewers.

There were over 100 councils represented at this conference, and a very large number took part in the discussion. The following resolution was then carried unanimously:—

> "That a report on the conditions prevailing in the West Riding be submitted to the Royal Commission on Sewage Disposal, with a request that they would consider the desirability of amending the law so as to bring about a uniform practice."

Acting on that resolution, the executive committee procured returns from a large number of West Riding authorities. Copies of these returns have already been submitted to the Commissioners. They indicate at a glance the extreme diversity of the practice of different local authorities when dealing with the subject. (Table handed in, *See* Appendix to Mr. Waller's evidence).

There is a strong feeling throughout the West Riding that the uncertain state of the law as to the discharge of manufacturers' effluents into the public sewers is very unsatisfactory. Section 15 of the Public Health Act, 1875, provides that—

> "Every local authority shall cause to be made such sewers as may be necessary for effectually draining their district for the purposes of this Act,"

and Section 21 provides that—

> "The owner or occupier of any premises within the district of the local authority shall be entitled to cause his drains to be emptied into the sewers of that authority, etc.,"

and from the above provisions it would appear and has been thought that every person entitled to connect to the drainage system of any local authority was entitled to empty into the sewers the whole of his refuse (except solids), whether domestic or otherwise. Those provisions, however, have been materially modified by:—

(1) The Rivers Pollution Prevention Act, 1876.

(2) The West Riding of Yorkshire Rivers Act, 1894, and

(3) The Public Health (Amendment) Act, 1890,

and the result of the different opinions with regard to the obligations under the Public Health Act, 1875, and the different constructions put upon the modifications of the amending Acts have caused confusion and diversity of practice with regard to the reception and rejection of various trade effluents in different districts.

As showing the great uncertainty which exists as to the rights of parties interested, I need only refer to the different opinions held by different district councils as to their duties and obligations and the rights of their ratepayers as to the sewage to be received for treatment, to the decisions given by Judges of the High Court in different cases, and to the decisions made by the Local Government Board itself.

For instance, in 1894 the Elland urban authority submitted a sewerage scheme to the Local Government Board, to which the Board took exception on the ground that it was proposed to receive into the sewers trade effluents, estimated at 50 gallons daily per head, and the Board suggested that the Elland authority should consider the desirability of taking steps to prevent the discharge of unpurified trade refuse into the sewers, the exclusion of solids alone not being, in the opinion of the Board, a sufficient safeguard.

In 1897, in the case of Peebles v. Oswaldtwistle Urban District Council, Mr. Justice Charles held "that the sewers mentioned in Section 15 of the Public Health Act, 1875, must be sufficient to take in the trade refuse of a district," but the Local Government Board, at an inquiry on the 21st June, 1898, at the instance of Messrs. Mallalieu, to consider a complaint against the Saddleworth Urban District Council that they had made default in not providing sewers sufficient to take their trade refuse, held "that the sanitary authority had not made default," thereby implying that, in their opinion, it was not the duty of the authority to make their sewers large enough to take the trade refuse of their district.

This diversity of opinion and practice is of the greatest moment to the manufacturers and others in the West Riding of Yorkshire, where mills, manufactories, and works of all descriptions abound, and more particularly in the small towns and villages in the midst of which I reside and carry on my business, and, in fact, the question is agitating greatly many urban and rural district councils within the West Riding at the present time.

I may as well say at once that this is not a personal matter to me. I am a manufacturer and spinner of cottons, yarns, and other materials, carrying on business in three separate mills, and employing some hundreds of hands, but there is no effluent discharged into the drainage system of my district from any portion of my business premises which ever has been or could be objected to as a trade effluent.

The present state of the law on the matter does not afford sanitary authorities any assistance in arriving at a decision as to whether they should or should not permit trade effluents to enter their sewers.

The practical result of recent cases appears to be that where trade premises are now discharging trade effluents into the common sewers they cannot be disconnected or otherwise stopped, but, on the other hand, sanitary authorities can prevent any trade premises not now connected from being connected.

The unfairness of this, from the point of view of the sanitary authority, is apparent because many of the connections were made before the duty of purifying sewage was enforced upon the sanitary authorities, and they consequently allowed connections with their sewers to be made without knowledge of the subsequent serious financial liability in which they were to be involved.

In fact, there are, no doubt, many cases where connections between trade premises and main sewers have been made in the first instance without the knowledge of the local authority.

In every case where the discharge of trade effluents into the sewer has become a "right" or an "easement," it is of great present and prospective value to the fortunate manufacturer in districts where no other trade effluents are now allowed to be connected. Advantages gained so fortuitously ought not to be allowed to continue to the prejudice of trade competitors in the same district.

I know myself of trade competitors carrying on their respective businesses in premises close to one another where the one is discharging his crude trade effluents into the common sewer, and the other is being made to treat them at his own expense, thereby giving a most unfair advantage to the one over the other.

For, whilst the manufacturer whose trade effluents are discharged into the public sewers has to bear his own share of the total cost of the purifying of the sewage of the district, including his trade effluents, the excluded manufacturer must not only pay his share of the rate paid for sewage purposes, but at the same time is liable to purify his own trade effluents at his own cost. This is manifestly unfair.

In districts with which I am familiar it happens that in two adjoining districts the authority of the one permits the discharge of trade effluents into their sewers, whilst the authority in the other forbids it.

The natural result will be that it will divert both capital and labour, and consequently rateable value, into the district where such sewage is treated, to the detriment of the adjoining district.

In fact, in a neighbouring district to that in which I reside—that is, in the Stainland District—a very large firm indeed (Messrs. John Shaw and Sons, Limited) are now threatening to remove their works altogether from the district, and have actually removed a portion of them, because the district council will not undertake the purification of their trade effluents.

This is a very serious matter, affecting as it does a very large number of working people in the district, on whom the loss of work might fall heavily.

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Again, many people, rather than occupy mills and manufactories in a district where trade effluents are not treated, prefer to rent rooms and power in a district where they are treated.

The present state of affairs is most unsatisfactory, and will probably lead to a great difference in local sanitary rates, due entirely to the accident of the presence or absence of mills and other manufacturing premises. This is not desirable, and might lead to serious local economic disturbance.

In consequence of the before-mentioned legislation directing the purification of rivers, sanitary authorities generally have either already constructed sewage works or are now doing so or contemplating doing so.

An enormous sum of money in the aggregate has already been spent, and an enormous sum of money still remains to be spent, upon these works, but the legal and practical difficulties are so great, and the economic interests involved so grave, that there is a general delay on the part of the sanitary authorities in deciding as to whether they shall or shall not admit trade effluents into their sewers.

It is felt strongly by my association that the matter should be dealt with promptly, and that whatever method of settlement be adopted, it should be upon the basis that all manufacturers should be dealt with alike in every district—that no advantage should be retained by reason of previous usage or admission of trade effluents into the public sewers, and that the rights, duties, and obligations of all sanitary authorities and manufacturers should be uniform respectively.

15900. (*Chairman.*) I gather, Mr. Waller, from the very interesting statement that you have put before the Commission that this matter has very little personal interest for you in this sense—that your own works do not contribute any important volume of effluent, or possibly none at all?—None whatever.

15901. And that your interest is due to your being a member of the Greetland Urban District Council and Vice-President of the West Riding Urban and Rural District Councils Association?—That is so.

15902. And that that association has a membership of 74 councils?—That is so, with a rateable value of over £3,000,000 of money.

15903. Well, that, of course, is a very important body, and we are very much interested in having your views. Those views are set out in a very lucid way in the paper which you have placed before us, and I propose to let that go upon the minutes as it stands; therefore, I need not trouble you to go through it in anyway, only that I shall ask you one or two questions bearing generally upon it?—Thank you.

15904. The main difficulty that you find is that there is no uniformity of action between these various authorities, and you suggest that that is due to the unsatisfactory condition of the law?—That is so.

15905. Well now, have you any definite suggestion to make to the Commission as to the nature of the alteration in the law that you think would meet the case?—Well, you are asking me something now I am not authorised to answer.

15906. Well, would you prefer I should ask your legal adviser, whom I see present?—(*Mr. Emsley.*) I think, Colonel, we are here on behalf of an association, and our instructions were definitely not to give any individual opinion, but to plead generally for the association as a body for some uniform action.

15907. Do I understand that your association, in coming before us, wishes simply to take up the position of fault-finding with the present condition of things, without making a suggestion as to how that condition of things should be remedied?—(*Mr. Waller.*) There is a great deal of truth in that, but we want uniformity of administration. In my evidence you will have noticed mention of a firm quite close to my factories (Shaws, of Stainland)—Shaw was a late member for Halifax—his works are quite close to ours. I saw him yesterday morning, to have another chat with him, to see if he would come to terms with Stainland. This is a letter he has written to the district council which is not in my evidence:—

"Brookroyd Mills.

"Dear Sir,—We are in receipt of your letter of the 9th inst. relative to the resolution recently passed by the council with regard to the treatment of the trade effluent from mills. We can see that the urban council in this resolution are expressing the opinion of the Local Government Board. We can only regret the decision of this Government Department, as, unless the council can undertake the purification of our effluents, we shall be compelled to remove machinery from this district. In fact, in anticipation of this decision, we have already removed some portion. We must point out to the council the very serious responsibility they take in endorsing this decision, affecting as it does a very large number of working people in the district, on whom the loss of occupation may fall heavily. Whatever may be finally decided by the council we hope may be for the welfare of the whole township.

"Yours faithfully,

"JOHN SHAW AND SONS, LTD.

"J. E. SHAW, Director."

The chairman said they could not do anything at present in the matter until they had had a communication from the Local Government Board. The Stainland Council asked the Local Government Board to come and interfere. They said, Will you kindly send an inspector, and say what shall Shaws pay; how can we deal with Shaws; will you appoint an arbitrator? Shaws say, "You will have to take our trade effluent"; the Stainland Council say, "We shall not," and the Local Government Board have written back to say they are very sorry they cannot interfere. They will have to settle it between them two selves.

15908. Do you not think that that is the ultimate issue you must always come to, that these matters must always be settled between the local authority and the manufacturer? Do you think, or does your association think, that it is possible to so modify the law as to make it applicable to all cases whatever? Must there not necessarily be a wide variety in regard to volume, in regard to the quantity of effluent, in regard to the special circumstances of the local authority, and to the size of the sewers, and to a multitude of other matters? Must there not be these special circumstances which must be considered in each particular case?—I agree with you that it is a very difficult matter to settle, but we do think this—we do think the Local Government Board should compel all councils to make some charge upon those individuals who are to-day turning their trade effluents into the sewer without paying a single penny towards the treatment of it. Now, in my own district, not a hundred yards from my own place, is a firm called Davies, the dyers. I went to see Mr. Davies on Saturday personally, about the matter, and he said to me: "Now, Mr. Waller, we are in an awful predicament; we are compelled to put down four tanks to deal with our effluents, while my brother, who carries on business not half a mile from me here, in Elland, and goes into the same market, because the main sewer of the Elland district goes quite close to his works he is allowed to discharge his crude effluents into that sewer for the Elland Council to deal with it." Our council refuses to take Davies' effluents because the sewage works are not large enough. Here are two competitors going into the same market; one man *ad lib* throws his crude sewage effluent into the main sewer, while poor Mr. Davies, close to ourselves, has to deal with his himself, and it is costing him pounds and pounds a year, and he says when he has taken his solids out, "It will neither burn nor make manure; I am piling it up in a heap; I do not know what I am going to do with it."

15909. We quite understand that position. Your difficulty is that certain firms have acquired more or less prescriptive rights?—Yes.

15910. And you seem to think that the law should be modified so as to act retrospectively upon those?—Exactly. I think these people have a perfect right to be called upon to pay something for the treatment of the sewage. I am a cotton spinner. If I was in Elland I should have to pay towards the treatment of another man's effluent, as well as pay my ordinary rates in the district.

15911. We note the point that you urge; of course, it is a difficult legal point?—It is, exactly: but we ask you to press upon the Local Government Board that some law should be made, whereby you can make it retrospective, and make everybody who is turning a trade effluent into the sewer pay something extra towards the treatment of the sewage.

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15912. Then you divide the question into two parts, first, with regard to those who have acquired rights by prescription, or otherwise?—Exactly.

15913. But, as matter of fact, are connected with sewers. You think that some arrangement should be made by which local authorities should have power to make bye-laws to regulate the flow into those sewers, although it may have taken place for a number of years?—Yes, I do.

15914. That is one side of the question. Then with regard to the other, perhaps more important side of the question, with regard to the future connections with sewers, have you any suggestions to make to us; do you think, for instance, that there should be thrown upon the local authority the distinct onus of showing why they should not receive an effluent into the sewers?—Now, speaking personally, I should be greatly in favour of giving more power to district councils for dealing with this question.

15915. Do you think that the responsibility of receiving these particular effluents should rest with the local authority, subject to their having power to make bye-laws?—I do.

15916. Is that the way you put it?—I do; that is exactly what I wish to say.

15917. And subject further without doubt to power of appeal to some outside body?—To some outside body.

15918. In the event of disagreement?—Yes.

15919. Now as to the body to which you would appeal, would you make such appeals to ordinary Courts of Law or to any specially constituted body?—I should prefer to put it to a specially constituted body?—I should prefer to put it to a specially constituted body, either to the county council, or to one appointed by the Local Government Board.

15920. (*Sir William Ramsay.*) Before you pass on, there is a matter which arises out of the last question. Would you put the local authorities under an obligation to take sewage into their sewers; under reasonable restrictions, of course?—Yes, I think I should, under reasonable restrictions.

15921. That is to say, the sewage system would have to be enlarged if it was not sufficiently large?—Certainly; unless we do that, we are going to retard the progress of certain towns, where there are factories, where there is no room to deal with it.

15922. (*Chairman.*) You think the only way to make the law generally applicable is to throw the obligation on the local authority, but leaving with them the onus of showing why they should not receive an effluent?—Exactly.

15923. And leaving with them the power to charge?—Leaving with them the power to charge, subject to an arbitration.

15924. Not only to make bye-laws, but to make charges in special cases?—Yes.

15925. Because it is quite true there may be a mill like your own, which is heavily rated?—Yes.

15926. Another mill next door, not so heavily rated, may be turning out an effluent which adds greatly to the expense of the local authority in treating it?—Horsfall and Sons, one of the largest blanket manufacturers in the world, are on the other side of the brook. They have spent nearly £2,000 in dealing with theirs, and a mill across the brook in the Elland district is turning practically some of the same effluent out without having spent a single penny; they are turning their crude sewage into the sewers; therefore, I say, the Elland Council ought to have that power of compelling these people to pay something for making the Elland Council deal with it; something ought to be done to give them power to charge these people, and make the power—not the charge—retrospective, subject to an appeal to a board.

15927. Then you think an appeal to the ordinary Courts would not be satisfactory?—I do not agree with that at all.

15928. They have not special knowledge, and probably it would be too costly, is that your view?—Yes, it is.

15929. And you think a central body in London, either directly connected with the Local Government Board, or an offshoot of it, specially applying itself to those questions, would be able to settle them better?—Yes. We might have Commissions coming from Whitehall into Yorkshire.

15930. Now, in the first instance, do you think it would be better to appeal first to the local Rivers' Board, subject to final appeal to the body you have mentioned?—Personally, I do not care for appealing to the Rivers' Board.

15931. What is the difficulty that you see?—Well, Rivers' Boards are a new body, and I think that the Rivers' Boards do not uniformly administer the powers they have. Mind you, in a few years, I might agree to them. If every Rivers' Board were as good as ours in Yorkshire I might agree to that, but I am afraid we should have a lot of grumbling in certain parts of the country.

15932. I do not understand; you do not leave final decisions to these Rivers' Boards?—No, I do not.

15933. But, as a court of first appeal, the Rivers' Board, upon which both parties, the local authorities and the local manufacturers, are represented, do you think that such a body as a court of appeal, in the first instance, might be useful in settling a great majority of cases?—Yes, I do agree with that, but I would not allow the final veto to be left there.

15934. You would give a power of final appeal?—Yes, to a properly constituted body by the Local Government Board. Mind you, the Rivers' Board are commercial men in Yorkshire, men who understand the work, and I think very likely they may be able to settle them without going any further; still, I would not allow them to have the veto. I would like to go further, because you may have jealousy.

15935. (*Major-General Carey.*) Where a manufacturer draws the water from a stream, it has to be returned to that stream?—That is so.

15936. Would you suggest that the refuse water should be treated in any way before being returned to the stream?—Certainly.

15937. And that the local authority should have power to insist upon it?—Certainly.

15938. That is quite irrespective of going into sewers at all?—Quite irrespective.

15939. That water taken from the stream should be sent back into the stream?—Yes.

15940. And if all trade effluent was treated alike, they would be all on one footing?—This is the hardship; you have in one district, people spending money treating effluent and turning it into the brook in a satisfactory condition, whereas another man, 200 or 300 yards away, does nothing whatever.

15941. A number of manufacturers have connected with the sewage system of the local authority without leave, have they not?—Well, that is so. Of course, one cannot give the actual time and day of the week when it was done, but it has been done, oh, yes. I may remark here, that our association, in chatting this thing over, thought that councils should have power to appoint assessors to value the contribution, which any person discharging trade effluent into the sewers should make to the sanitary rate.

15942. (*Chairman.*) Any special contribution, beyond his ordinary rates?—(*Mr. Emsley.*) That all trade premises should be assessed for sanitary purposes separately.

15943. You think it is quite practicable for a local authority to assess the extra cost to be thrown upon a manufacturer?—(*Mr. Waller.*) We do think it is perfectly practicable. (*Mr. Pindar.*) They would appoint a specially qualified man, as the assessment committees of Boards of Guardians do, where necessary. (*Mr. Waller.*) There is no part of the country, there is no part of the United Kingdom where there is such a volume of trade effluent as we have in the West Riding of Yorkshire. Take Lancashire; in Lancashire you may have congested districts of factories, but you have no congested districts where they are making trade effluent. In Lancashire it is largely cotton-spinning, and cotton-spinners are only using water for condensing purposes. In Yorkshire we are creating more difficult trade effluents than any other part of the United Kingdom.

15944. Well, we are glad to gather this from you. You say that you certainly agree that something should be done to prevent the pollution of rivers?—We do agree.

15945. And that either by the local authority or by the manufacturers this work should be done?—We do.

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15946. But, speaking generally, you think it would be better done wholesale by the local authority than specially in each case by the manufacturer?—Yes, we do. There are mills in Elland, for instance; in my evidence you will notice that the Local Government Board refused to give Elland permission to borrow money for their sewage works because they were accepting trade effluents. Well, after months and months of correspondence between the Local Government Board and Elland the Local Government Board gave way, and Elland to-day, of course, are taking trade effluents.

15947. Are you not possibly mistaken there in supposing that the objection of the Local Government Board in this case was to their taking trade effluents; would it not rather be that if they took these trade effluents they must enlarge their scheme?—Well, the wording of the letter was to the effect that, We notice that you are intending to deal with trade effluents.

15948. Quite so; but that would involve, of course, a larger scheme probably than they were laying before the Local Government Board?—The Chairman did not give me to understand that.

15949. We have no knowledge of that officially, here?—No. We cannot go into that, but we think it is perfectly practicable, as I said before, that this thing can be more satisfactory than it is; we are perfectly sure of it.

15950. Then, condensing all that we have been saying and your report, I suppose we may take it that the view of your association is that if possible the law should be modified so as to give power to local authorities to make bye-laws in regard to those cases which have already been connected with the sewers, and, if need be, to make certain charges upon manufacturers who have been so connected; and that in regard to the future that the obligation should be thrown on the local authority to receive trade effluents, subject to a power to make bye-laws, and subject, on the other hand, to appeal to some outside body?—I agree. (*Mr. Emsley.*) And to assess the premises; and, having regard, as you will know very well, to the great number of business premises there are without land upon them to treat their sewage at all.

15951. The special circumctances of each case must evidently be considered?—(*Mr. Waller.*) Exactly, and that is really the case in Elland, where there are mills without a yard of spare ground.

15952. And a good deal of the difficulty arises in this, that you cannot get the local authcrity to say one way or the other?—Yes.

15953. If the obligation were thrown upon them, then they would be bound, would they not, either to accept it or say why they did not accept it? That would bring the thing to an issue. There was a special meeting of the Meltham Council held, apparently, not so much with the object of determining the course of action as of inquiry as to how far the Council were obliged to take into the sewers trade effluents for purification:—"Two distinct inquiries on sewage (amongst other things) have been held (1895 and 1896), and yesterday evening a good deal of time was consumed by the Chairman (Mr. S. Brook), who contended that they were not pledged to receive the effluents from mills, and by Mr. J. H. Preston, who held the opposite view, in interpreting the evidence given, more particularly on this topic. The Chairman contended that there was no distinct pledge, but admitted that the evidence showed that there had been in the sewerage scheme propounded provision made for the reception of trade effluents. Mr. J. B. Hirst objected to an expensive scheme of sewage being carried out by the ratepayers to treat trade effluents from mills, which ought to be purified by the mill-owners themselves. The Chairman, in the course of further discussion, said that the Council were not pledged by resolution to deal with the trade effluents, and that would be necessary before they could proceed further in that direction." Another instance of difficulties of opinions in councils. You find it all over the West Riding.

15954. (*Major-General Carey.*) Would you suggest that the council or the local authority should have power to insist upon preliminary treatment, if necessary, by the manufacturer before the effluent is taken into the sewers?—Certainly, where such council can show to the mill-owners that they have room to do it. That in all cases where a factory has land where they could put down settling tanks, and deal with it, I should insist upon that being done, and where they have no land, then I would say, give the council power to come to terms with them as to what they will charge, subject to appeal.

15955. For the treatment of the effluent at the works?—At the works, yes.

15956. At the outfall works?—Exactly, yes; and I think it would not be a bad idea if the Local Government Board were to instruct districts that are putting down new sewage works to lay separate mains. My own private opinion is, lay separate mains for trade effluent and for domestic sewage.

15957. (*Chairman.*) Do you say the Local Government Board ought to take the responsibility of saying whether that should be done or not?—Well, not exactly go so far as that, but I think it would be a great saving to all local authorities where they are putting down new schemes to instruct them to put down separate sewers altogether.

15958. There are several ways of looking at that?—Oh, there are.

15959. Some people who have given evidence before us say it is undesirable to have separate sewers. That is one of those matters, among many others, which ought to be considered locally, according to the circumstances?—Yes, oh yes.

15960. We thank you for the interesting evidence which you have brought before us in connection with your association, and to which we shall give every attention?—We are extremely obliged to you for asking us to come up here, not only to give you our evidence, but as a recognition of our new association, which we have formed in Yorkshire. It is a new association. We have grown considerably, both financially and numerically, and we think we are looking after the interests of the health of the West Riding of Yorkshire, and we are pleased to have been up here, and we thank you for the cordial manner in which you have received us.

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APPENDIX to Mr. *Waller's* Evidence.

WEST RIDING DISTRICT COUNCILS ASSOCIATION.

STATISTICS RELATING TO TRADE EFFLUENTS.

BY direction of the Executive Committee the following Table has been prepared for the information of members of the association. It shows the replies received in response to a circular letter of inquiry sent out by the Committee, asking for information on the points specified in the headings of the several columns.

Thirty-seven councils report that there are no trade effluents in their district, and for this reason are not included in the Table.

URBAN.	URBAN.	RURAL.
Ardsley.	Holme.	Barnsley.
Ardsley East and West.	Hoylandswaine.	Bishopthorpe.
Barnoldswick.	Knottingley	Bowland.
Birkenshaw.	Methley.	Hemsworth
Bolton-upon-Dearne.	Netherthong.	Keighley.
Calverley.	Scammonden.	Kiveton Park.
Castleford.	Selby.	Knaresborough.
Emley.	Shelf.	Leeds.
Flockton.	Slaithwaite.	Great Ouseburn.
Gomersal.	Stanley.	Pateley Bridge.
Greasbrough.	Whitley Upper.	Penistone.
Hebden Bridge.	Whitwood.	Ripon.
		Wharfedale.

Four districts have not yet provided a sewerage system—Rishworth, Shelley, Shepley, Keighley (Rural).

A Joint Sewerage Committee has been formed to include the Shelley and Shepley urban districts, and the Committee have resolved to exclude trade effluents from the public sewers.

Trade effluents are admitted conditionally into the public sewers in four districts—Burley-in-Wharfedale, Linthwaite, Marsden, Skipton (Rural).

Sixteen councils admit trade effluents and treat them unconditionally—

Golcar.	Horbury.	Liversedge.	Halifax (Rural).
Hipperholme.	Kirkheaton.	Queensbury.	Hunslet (Rural).
Holmfirth.	Knaresborough.	Rawdon.	Sedbergh (Rural).
Honley.	Linthwaite.	Thurlstone.	Settle (Rural).

Twenty-nine councils refuse to admit trade effluents into their sewers—

Baildon.	Kirkburton.	Oxenhope.	South Crosland.
Denby and Cumberworth.	Lepton.	Ravensthorpe.	Soyland.
Denholme.	Meltham.	Saddleworth.	Stainland-with-Old Lindley.
Greetland.	Midgley.	Shelley.	Stocksbridge.
Handsworth.	Mytholmroyd.	Shepley.	Thurstonland.
Haworth.	New Mill.	Shipley.	Rotherham (Rural)
Ilkley.	Normanton.	Soothill Upper.	
	Oakworth.	Soothill Nether.	

In the Shipley Urban District there is one tannery discharging into the public sewers, the proprietors having acquired the right to maintain the connection by lapse of time.

Hunslet, Leeds, 5th August 1902.

W. B. Pindar,
Hon. Sec.

Mr. H. H. Waller, Mr. R. B. Emsley, and Mr. W. B. Pindar.

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Urban Councils.	Rateable Value of District.	Number of Works discharging Trade Effluents.	Rateable Value of same.	Number connected to Sewers Conditionally.	Rateable Value of same.	Number connected to Sewers Unconditionally.	Rateable Value of same.	Observations.
Baildon - - -	22,755	2	1,148	None	—	None	—	
Burley-in-Wharfedale	—	—	—	—	—	—	—	No works discharge trade effluents into sewers without first treating same on their own premises to the satisfaction of the Council.
Denby and Cumberworth.	11,119	3	724	None	—	None	—	
Denholme - -	15,595	1	2,269	None	—	None	—	
Golcar - - -	29,987	23	8,685	None	—	4	1,388	
Greetland - -	19,830	7	2,660	None	—	None	—	
Handsworth - -	45,312	1	127	None	—	None	—	
Haworth - - -	17,968	3	2,788	None	—	None	—	
Hipperholme - -	23,850	4	1,645	None	—	4	1,645	
Holmfirth - -	24,291	50	8,000	None	—	One mill and a few small works.	400	
Honley - - -	18,083	14	4,008	None	—	1	563	
Horbury - - -	37,141	11	4,963	None	—	11	4,963	
Ilkley - - -	57,122	3	427	None	—	None	—	
Kirkburton - -	7,589	2	372	None	—	None	—	
Kirkheaton - -	12,986	1	565	None	—	1	565	
Knaresborough -	13,000	2	94	None	—	2	94	
Lepton - - -	8,178	3	589	None	—	None	—	
Linthwaite - -	23,789	19	8,140	2	196	8	5,852	
Liversedge - -	45,406	11	3,015	None	—	11	3,015	
Marsden - - -	26,195	7	—	1	451	None	—	
Meltham - -	27,487	10	5,727	None	—	None	—	
Midgley - - -	9,253	2	1,777	None	—	None	—	
Mytholmroyd - -	23,140	—	—	—	—	—	—	Only a small portion of the sewer laid as yet. The Council do not propose to treat trade effluents.
New Mill - -	11,998	9	1,698	None	—	None	—	
Normanton - -	28,806	—	—	—	—	—	—	No works discharging into the Council's sewers. A chemical company treat their own effluent and discharge same into beck.
Oakworth - -	10,432	3	1,607	None	—	None	—	
Oxenhope - -	12,387	5	765	None	—	None	—	
Queensbury - -	24,667	2	6,538	None	—	2	6,538	
Ravensthorpe - -	23,882	1	100	None	—	None	—	
Rawdon - - -	14,332		315	None	—	1	11	
Rishworth - -	—		—	—	—	—	—	No public sewers as yet.
Saddleworth - -	75,742	25	—	None	—	None	—	

Urban Councils.	Rateable Value of District.	Number of Works discharging Trade Effluents.	Rateable Value of same.	Number connected to Sewers Conditionally.	Rateable Value of same.	Number connected to Sewers Unconditionally.	Rateable Value of same.	Observations.
Shelley - -	5,070	2	224	None	—	None	—	The two works referred to discharge direct into the river. Sewers not yet laid but Council have resolved not to accept trade effluents.
Shepley - -	7,829	6	2,264	—	—	—	—	No sewers at present. Trade effluents discharged into beck. Joint board has been formed and has resolved not to treat trade effluents.
Shipley - - -	108,000	—	—	—	—	1	—	There is a tannery discharging into a public sewer, but they have acquired the right by lapse of time and cannot now be prevented. The Council have resolved not to take trade effluents into the sewers.
Soothill Upper -	27,068	12	4,064	None	—	None	—	
Soothill Nether -	18,228	4	836	—	—	—	—	
South Crosland -	—	3	2,405	None	—	None	—	
Soyland - - -	13,992	1	51	None	—	None	—	
Stainland-With-Old Lindley.	17,617	10	4,707	None	—	None	—	
Stocksbridge - -	25,004	1	9,062	None	—	None	—	
Thurlstone - -	30,163	3	300	None	—	3	300	
Thurstonland - -	6,249	2	1,548	None	—	None	—	
RURAL COUNCILS.								
Halifax - - -	15,507	1	520	None	—	1	520	
Hunslet - - -	42,902	1	1,740	None	—	1	1,740	
Rotherham - -	134,811	7	—	None	—	None	—	All collieries.
Sedbergh - -	31,932	3	436	None	—	1	60	
Settle - - -	143,620	3	351	None	—	3	351	
Skipton - - -	154,183	1	7	1	7	None	—	

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Mr. J. S. Martin.

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Mr. JOSEPH SAMUEL MARTIN, one of His Majesty's Inspector of Mines, called in; and Examined.

15961. (*Sir William Ramsay in the Chair.*) You are one of His Majesty's Inspectors of Mines in charge of the Southern District of England?—I am.

15962. I think we should like to be informed if you think that mines are a great cause of pollution to the water supply—the rivers of this country?—They do cause pollution, more or less.

15963. I suppose that pollution can be divided into two heads, pollution from sediment, and pollution from dissolved matter?—Yes, that would be so.

15964. And the sediment, I presume, largely comes from coal washing?—In the coal mining districts, but in the metalliferous mining districts from sand and resulting salts and acids.

15965. Purely sand; is that an objectionable thing?—In September, 1901, there was a case down in Cornwall where the County Council applied to the Local Government Board for permission to take proceedings against a mining company in Cornwall for polluting the Tamar and its tributaries. One of the inspectors from the Local Government Board was sent down to hold an enquiry which was held at Tavistock, and it was shown there that at times there was a very considerable amount of silt or sand went away from this tin mine. That would be after the ore is crushed into very fine sand and the tin extracted from it, the refuse or slime was not all deposited in settling tanks, and part of it went into the rivers, which was objected to by the County Council. The Local Government Board did not in this case see their way to grant permission to have the proceedings taken, and since then things have been improved a good deal.

15966. The only damage that sand could do, I suppose, is in silting up the river?—It was also considered injurious to the fish, I think, to a certain extent.

15967. (*Major-General Carey.*) They were lead and tin mines, I suppose?—They were tin and copper mines.

15968. Tin mines and lead mines?—Tin and copper.

15969. And lead mines?—Not in that instance.

15970. No, but it would apply?—It would apply,

15971. (*Chairman.*) You are speaking of pure sand, which would not silt up; you are not speaking of particles of tin oxide, which would not do any harm?—They would not do any harm, but there was copper, and some of the sulphates were finding their way into the river; they complained of those also.

15972. Then would this difficulty be obviated by allowing the solid matter to deposit? Was there any solid matter in solution delivered into the river?—Yes, there were copper solutions.

15973. There would be no trouble in depositing the copper?—It was there said in evidence that it might easily be neutralised by passing them over chalk.

15974. Or scrap iron?—It was what passed away from the scrap iron tanks, which, I presume, were not sufficiently large, that was considered rather strong.

15975. Is it acid?—I think so; it would be sulphate, I think.

15976. Such cases are not very common, but when they occur can they be easily obviated?—They can at least be obviated more or less, if not entirely.

15977. Without any great expense to the mine owner?—Not altogether. I would not say that it could be done altogether, but it could be moderated. I am not sufficient chemist to say exactly to what extent it could be done.

15978. Or whether it could be reduced to such a limit as to be innocuous?—To some extent, yes.

15979. To some extent?—I understand that in some of the tin works in Monmouthshire, they use acids in the process, and that those give a good deal of trouble to parties connected with fisheries.

15980. We have had some evidence as regards those effluents, and I think there is no great difficulty, as a rule, in neutralising them?—So I am informed; in fact, in one case, near Pontypool, I believe the effluent is so neutralised that small fish will live in it, but it requires care; it requires an expenditure for the arrangement—copperas arrangement— and care in manipulating it.

15981. Do you think that such places should be under supervision, so as to see that they actually take sufficient care and pains to remove it?—I think so in such cases, because they directly use strong acids.

15982. Something in the nature of inspection would be required to see that the river is not contaminated with metallic salts or with acids?—Yes; I think in those cases it would be desirable. Of course, parties connected with fisheries look pretty closely after it themselves.

15983. When you spoke of sand, did you refer at all to very finely divided sand, which would not settle, and which interfere with fish by merely its mechanical presence in the water?—That would be so when it was in large quantities, as was complained of in that instance.

15984. Was that a case of very finely divided sand?—Very finely divided sand.

15985. That would be more difficult to deal with, and would involve the effluent remaining in settling tanks for a considerable time?—It would require to remain in settling tanks for a considerable time, and it would require settling tanks of considerable size to allow it to flow very quietly.

15986. Are you acquainted with any kaolin works, china clay?—Yes.

15987. Do they discharge their unsettled tank liquor into rivers?—Some of the streams in Cornwall are running white, carrying away, no doubt, a considerable quantity; I will not say rivers—streams that have come under my notice.

15988. Is that supposed to interfere with fish life in the stream?—That I cannot say.

15989. You have had no complaints?—I have had no complaints.

15990. Then, coming to coal, I suppose it is perfectly possible to settle coal washings, and prevent the finely divided coal getting into the river?—To a very large extent. In that case also, I would not say it was possible to do it absolutely without very considerable expense.

15991. Is it done?—It is capable of being done to a very much larger extent than it is in some instances.

15992. You think there is great room for improvement?—I think so. I speak now from Monmouthshire, where the coal washeries pollute the Rhymney River which divides Glamorganshire and Monmouthshire, the Ebbw with its tributaries, the Sirhowy, the Ebbw Fach and the Ebbw Fawr to the detriment of fish.

15993. With coal dust?—With coal dust and effluent from coal washing.

15994. There, again, it would be a question of limiting the number of grains per gallon?—Yes, I should think it would be.

15995. And I suppose in the case of coal, which colours the water and prevents it being transparent, one would require to have a different standard from ordinary solids, a different standard of pollution; one would require to make a smaller quantity of coal count as suspended solids than one would if they formed a white precipitate, as in the case of clay washing. I am thinking of fish life again. Is it not a disadvantage to shut out the light from the water?—Yes, I should think so; but I think that the clay, the china clay, would do so also.

15996. To the same extent as the coal?—I should think it would make it quite opaque.

15997. Are you acquainted with any other source of pollution besides copper; have you experience of iron or lead mines?—No; I would not be able to speak from experience on these points.

15998. We have been told that very often, in the case of old coal workings, from pyrites in the coal, the pits get full of water, the pyrites oxidises, and turns into sulphuric acid and iron in the liquor. The iron does not very much matter, but the overflow which runs into the stream is very acid. Have you come across any cases of that kind?—I understand that the pumping out or unwatering old mines does affect it.

15999. But the actual overflow would not be very important?—I do not think so myself; I have not heard of it; it has not been brought under my notice. I know that in some cases the pumping out of or unwatering old workings which have been standing for a length of time, the water has had time to get into a

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stronger solution than would be the case when the running feeder is kept pumped out.

16000. Then does lead often pollute water—drainage from lead mines?—I cannot speak as to the effect of lead mines. In my district at present I may say practically there is no lead worked. There were lead mines when I was in the Manchester district, and there were lead mines in County Wicklow, but this subject did not come under my notice at that time.

16001. Is there any other source of pollution that you can suggest of a metallic character?—No, I do not think there is.

16002. Arsenic does not come in, I suppose?—Arsenic itself?

16003. In any form?—I do not think so. The arsenic works principally in the neighbourhood of rivers were those at Devon Consols, in Devonshire, near Tavistock, and another lower down, Gawton, but I think they made satisfactory arrangements. Formerly there were complaints, but for years past I have heard of none. Unfortunately, these arsenic mines which used to, I think, produce more than half the arsenic of the world, have just been stopped.

16004. The price is very low, I know?—The price is very low; it has gone up again. The stopping of this mine has affected the supply; it has helped other people.

16005. (*Colonel Harding.*) Many of the instances that you have given us, Mr. Martin, of pollutions arising from mines are pollutions arising from processes carried on in the mine, in which they either use acid or some other chemicals in the treatment of their metals or their ores, so as to produce the resultant pollution which has distinctly resulted from the manufacturing process?—No, they do not use acids at the mines, but in the natural course of working the water absorbs various salts and acids in passing over the minerals. It is the dressing process I speak of.

16006. It has been suggested to us that there are other cases in which pollution arises from water which is pumped from mines, which water is not the result of the manufacturing process; it is a natural flow of water in the mine which brings about the acid in the stream which it reaches. Have you any personal knowledge of the district in the neighbourhood of Sheffield where it is suggested to us that in many mines ochre water is pumped into the river, which causes the river to be so acid as to be unfit for use in boiler?—That would be so, especially in the case that I speak of in copper mines.

16007. Then in that case it is not a manufacturing process that produces this acidity; it is the natural condition of the water at the bottom of the mine?—That would be so.

16008. That is so, is it?—That would be so. In Cornwall they used in former times, in some of the mines, to have to line their pumps with wood in order to prevent the water touching the iron, as it ate it away; it corroded it so fast that the pumps practically could not be worked without some such precaution or use of bronze, etc.

16009. If the water were not pumped out in such a mine, causing the nuisance that I am referring to, what would become of the water; would it lie there stagnant, or pass away in a lower strata?—The mine would be drowned out.

16010. There is, I am told, a legal difficulty, that Rivers Boards cannot take action against mineowners for pumping this acid water out of their mines and turning it into a stream, although their doing so causes great inconvenience to riparian owners?—Well, it lies always between two things—which interest is the most valuable in a manufacturing district. If the riparian interests are the more valuable, of course, the mines must succumb to them, but the water must be got rid of from mines if they are to be worked.

16011. Have you any opinion of your own as to any artificial means of purifying water pumped out, to remove the acidity; do you know whether it would be a serious cost or not?—I am afraid I am not sufficient chemist to answer that question.

16012. Have you ever heard of its being done?—It may be done in some instances on a small scale, but I do not think we have arrived at a practical point where such could be done, for instance, dealing with such quantities as 15,000 to 60,000 gallons an hour. As I say, it is a chemical subject which I am not prepared to express an opinion upon.

16013. (*Chairman.*) In order to get the ore to the surface you have to mine it; in order to get the ore you have to keep the mine clear of water?—That is so.

16014. The pumping of the water must surely be regarded as a part of the whole manufacture of the metal; it may be rather remote, for without pumping the water the ore cannot be extracted, and the metal cannot be produced.

(*Colonel Harding.*) It is urged that water so pumped is a natural and not a manufacturing process.

16015. (*Chairman.*) If not, it would stay there?—It would stay there, but whether it would contain these noxious ingredients or not is another question.

16016. I doubt whether it would; it is the working of the mine, it is the action of the air and the water together. If you do not let air into the mine you do not get oxidation. I think it might be argued very well that it is part of the manufacturing process?—There was a case in the Tave, I think; it did not come to my knowledge directly, but one of the mines down in Devonshire, where the pumping of the water from the mine was alleged to have destroyed fish on a considerable scale. It was in Bertha Consols Mine, situated about four or five miles below Tavistock.

16017. Are such waters drunk?—Oh, no.

16018. They do not serve for drinking-water supply?—No, I think not. The copper water, I should say, would be distinctly injurious.

16019. (*Major-General Carey.*) If water was pumped up from a lead mine into a stream, and the stream had been used for drinking water by the inhabitants on the banks, the fact that this water was being pumped up would hardly be known except by its effect upon the population. There is nothing to prevent it?—That would be so. I think they said in evidence with regard to the Prince of Wales Mine case that I spoke of, where so much matter was in suspension, and where also there were these copper salts, that the cattle drank it without injury, and I am not prepared to say at the present moment whether they drank it themselves or not, but I should not like to drink it if it were put before me.

Captain Anderson.

Captain ANDERSON, called and Examined.

16020. (*Chairman.*) You are Chairman of the Whitstable Oyster Fishery Company?—Yes.

16021. You have been Chairman for 15 years?—I have been Chairman for 15 years.

16022. You are also Vice-Chairman of the Kent and Essex Sea Fisheries Company?—Yes.

16023. You point out in your statement that the extent of the oyster, mussel, cockle, and whelk industries is very considerable?—Yes; very considerable.

16024. Do you think that a capital of £250,000 would represent the industry?—No; £250,000 represents the capital of my company alone.

16025. And there is a very much larger capital concerned at present?—Yes. My company is only one out of many, and inasmuch as there are no statistics that I have seen that show the amount of capital invested in the oyster and shell fish industry, I only give you the capital of my own company.

16026. (*Colonel Harding.*) We understand that there are other companies in the district beside your own company?—Yes, there is another company in my particular district.

16027. And there are a number of companies with considerable capital in that district, the Whitstable district?—Yes, and there are many more round the coast of England, Scotland, and Wales, particularly Essex.

16028. (*Chairman.*) It would not be possible, I suppose, even to arrive at an estimate of the people employed in this industry?—No.

16029. (*Mr. Power.*) Is the Board of Trade any authority on the subject?—None whatever; I could only give the number very roughly.

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16030. (*Chairman.*) That will be better than nothing, if you could give us some sort of idea?—As to the capital value of the shell fish industry round the coast?

16031. Yes. You might say that it did not exceed some approximate sum?—Well, I should think it would be something between £6,000,000 and £8,000,000.

16032. You know more about the number of hands employed in this industry in your own particular company?—Yes.

16033. You have 120 men, I see you say?—We have about 120 men that we employ all the year round.

16034. And occasionally others?—Only occasionally, when we are very busy. On an average, we employ 120 men all the year round.

16035. Would it be fair to state the same in proportion, and say that the other companies employ a proportionate number of men?—Certainly.

16036. You speak here of the importation of shell fish, and say that there is a considerable importation of shell fish into this country from abroad. I should like to ask you if these oysters or these shell fish are laid down in this country on arriving or are delivered straight to the consumer?—In some instances they are brought over here for planting purposes; that is, they are laid on the beds for one, sometimes for two, and sometimes for three years. The oyster so laid down commands a better price than the oyster that is brought over and sold direct to the public. It is the French oyster I am now referring to.

16037. Are the majority of oysters laid down, or are the larger number sold as they arrive?—If you mean Americans—I will leave Alderman Petrie to speak of those—but I believe there are many more Americans sold direct than there are laid down; but I cannot say with any certainty. Speaking, however, as to French oysters, very many more are brought over and laid down for planting purposes than are brought over and sold direct to the public.

16038. Are the places where they are laid down under control at all?—In which way do you mean?

16039. I mean, do you pay particular attention to their being in safe places, not exposed to sewage pollution; or is there no particular attention paid to that? I presume there are beds which have been used for laying down oysters for many years?—Yes.

16040. These go on being used, I presume, as a matter of custom?—That has been my experience.

16041. There are not very many new places for laying down oysters?—No, none that I know of; in fact, the places for oyster culture round our coast are limited, and I should think they have been taken up years ago; but I wish to say that up to the present there has been in some quarters an absolute disregard of the sanitary conditions surrounding those beds.

16042. Do you think that the oysters that are introduced into this country bring pollution with them, or do they get polluted by happening to be laid down in polluted places? One could imagine that an oyster two or three years in fresh water would have had ample time to clear itself of pollution?—I believe it is an acknowledged fact that, provided you get a polluted oyster and he is placed in a fresh bed where there is a current of pure water, 21 days is sufficient to cleanse him, and I believe he is then a safe article of food.

16043. Then you refer to the pollution of foreign oysters merely from the point of view of being sold immediately?—I am referring in two ways to foreign oysters. I know of foreign oysters that have come from polluted sources and sold direct to the public, and also foreign oysters which have been laid down in polluted beds in this country and subsequently sold to the public.

16044. Do you wish to convey that the foreign oysters convey pollution with them and that they affect unaffected oysters in beds in which they are laid down?—No, not at all. I do not suggest that for a moment.

16045. I see you recommend that oysters coming into this country should be described by letters on the bags or packages, showing the place from which they are imported, the class or name of the oyster by which they are known, and that all imported oysters should be sold under such description?—Yes; and I do so on these grounds. I think oyster-planters in this country have now come to the conclusion and are very anxious that all oyster beds should be put upon a satisfactory footing; and what the oyster-cultivators say is that if we around the coast are anxious to put our oyster beds in a proper and efficient state, then we think that the oysters from abroad should be pure, and not come from polluted sources. It is upon that ground that we make this recommendation.

16046. (*Major-General Carey.*) Where is the guarantee that they are free from pollution. They are merely described as coming from a certain part?—Any package coming from abroad should have also its source and origin marked upon it We would leave it to anyone that is appointed to say whether these oysters do come from polluted sources. There are polluted sources abroad which are well known and from which oysters should not be sold direct.

16047. (*Mr. Power.*) The sources abroad liable to send polluted oysters are well known in this country?—They are well known to the trade

16048. (*Major-General Carey.*) But the consumer would not know them?—The consumers would not know them, and therefore they should be protected against them.

16049. (*Mr. Power.*) That is one of your reasons for demanding that they shall be labelled with the place from whence they are derived?—That is the reason, coupled with the fact that all English planters are now anxious to put their beds in order. We are anxious that the beds shall be put on a satisfactory footing, and, inasmuch as we are anxious that the public should have a thoroughly good article, we want the guarantee all round.

16050. And if the foreign oyster sources which are polluted are well known in this country, the labelling which you advocate would suffice, you think, to secure the public against oysters from doubtful foreign sources being placed direct on the market?—Quite so.

16051. (*Chairman.*) Are the foreign shipments sold direct to the consumer, or are they all discharged through the wholesale houses?—Generally through the wholesale houses.

16052. It occurs to me that when we insisted on the Germans putting a label on their goods some years ago we then gave them a gratuitous advertisement. Is it not quite feasible that this might take place again?—We are quite willing to take that risk, because it is well known there is no oyster in the world like the English oyster, when properly fished.

16053. (*Colonel Harding.*) Would not an arrangement of that kind be looked upon in some directions as a protective measure on behalf of the local oyster industry?—I cannot possibly conceive that.

16054. Commercial protection?—No, I cannot conceive how that could arise either.

16055. (*Chairman.*) It was found, I think, that the effect of the label was to induce people to buy German articles?—I cannot say; in many cases it has not. We want to put our beds in order, and we really do want to allay this suspicion, in order that the British public may be assured that they get the pure oyster all round, but if we put our houses in order, independent of the other, we say there will be no guarantee and there will still be danger of polluted oysters coming into this country.

16056. (*Chairman.*) Is there any danger of the different oysters being mixed in the handling of the trade?—I do not think that is done, or any danger of that sort likely to arise.

16057. They are all kept separate?—In the trade they call a spade a spade, and if they sell Whitstable natives they sell them, and if they sell French they sell them, and if Dutch they sell them, and so on.

16058. As such?—As such. Of course, there might be two or three reprehensible people, but, speaking of the trade generally, I have not seen much, if any, of that done.

16059. (*Colonel Harding.*) In fact, it is already accomplished, and the source of the supply of oysters is known to the public?—The best oysters are well known to the public. It is the polluted oyster that we want the public to be protected from.

16060. You say that foreign oysters are almost invariably sold as French, American, or Dutch oysters. Then where would the difficulty arise?—In this way—the selling of them under their proper name or description is one thing, but under present conditions how are the public able to discriminate whether the oyster they buy is pure or not?

16061. (*Chairman.*) I put another question. Supposing they were laid down in your beds, would you still call them French oysters?—Yes, nothing else. We never call a French oyster by any other name, and I can produce price lists year after year. We bring our French oysters over, and lay them from three to four years, and he always remains a French oyster, and is sold as such.

16062. Even if he is relaid in England?—Yes, he grows, but he does not partake of the species of an English oyster.

16063. (*Major-General Carey.*) Then the fact of his being a Frenchman would not condemn him for food?—Not at all. The French oyster is a very good article of food, so long as he is pure.

16064. How is the consumer to know whether he is pure or not?—That is exactly what we want to get at. The English planters want all their beds to be in perfect order, and in return they say it is only fair and reasonable that foreign oysters from polluted sources should not be allowed to be imported into this country.

16065. And how is that guarantee to be given to the English consumer?—Because all of us, who know anything of the trade, know by the source and origin whether it comes from a polluted source or not.

16066. And is the consumer to know that from the oyster merchant in England?—No, not exactly, because the proper officers which I assume would be appointed would say at once these oysters come from a polluted source, and we prohibit them being sold to the public.

16067. (*Colonel Harding.*) Now, would it be possible for any English Government Department to lay down regulations for the inspection of the foreign sources?—That would not be necessary, as polluted beds or sources are, or ought to be, known to those who would be called upon to control or supervise the oysters that reach the public.

16068. I do not know of any English Government Department that would have any right to go and examine these conditions and give a certificate accordingly?—I think, if foreigners are going to trade in the English market, they should come under the same conditions as the English trader, and satisfy the proper authorities that their beds are in a proper state of cultivation to supply pure oysters.

16069. Do you suggest, as a sort of guarantee of the safety of the foreign oyster, that it should be laid down for a given period, say, a month, in English waters?—No, I do not go so far as that, because there are plenty of oysters come from abroad which are as perfectly pure as ours, and I say it would be wrong to prohibit that class of oyster coming direct to the public. They are a good, proper, and nutritious oyster, fit for the public to eat, but what I want to guard against is those oysters which come from polluted sources.

16070. (*Chairman.*) You would treat it in the same way as the cattle problem is treated. If there is a question of diseased cattle coming from abroad, importation is forbidden?—Exactly. If you will allow me to say so, we have arrived at a point when our trade is threatened, and we, the oyster planters round our coast, come before you and say unanimously we are most anxious that something should be done in order that oysters may be put once more on a proper footing and the sewage removed. What we say is, if we are desirous of doing so, then let us be protected from the foreign polluted oyster. I have got no antipathy as against the foreign oyster, but I have against the polluted one, whether English or foreign.

16071. (*Colonel Harding.*) I might, at this stage, ask if Captain Anderson knows of any supervision of the French, or Dutch, or Belgian Government for the protection of oysters?—The French and the Dutch Governments exercise very great care, I may say paternal care, over their oyster fisheries, in the protection of them, and so on, but I know of no care as to their sanitary conditions.

16072. (*Chairman.*) Then you think that the authority to judge of the state of oysters admitted into this country through the Fisheries Board, or some body analogous to the Fisheries Board, would be an advantage?—I do.

16073. You think they are already possessed of the right kind of individual, the skilled people, who are not the wholesale people?—That is the point. Who at present constitute the Fishery Board in England?

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16074. (*Mr. Power.*) You would have a Fishery Board constituted for this purpose, a new Board?—Yes. We, the oyster merchants, have lately met in conference under the roof of the Fishmongers' Company, and have by their assistance been enabled to do a little; but, unfortunately, the shell fish trade have no Department that I know of where they can be protected or give assurance to the public. For instance, let us go to the Fisheries Department of the Board of Trade. That is now merged in the Harbour Department, a very excellent body by itself, but, being merged, I question very much whether their duties are not too large to enable them to give us proper attention, and I am speaking now of the fishing industry as a whole. It has been felt for some time that the fishing industry is not adequately represented, and that the time has arrived when there should be a newly constituted Board of Fisheries to look after the interests and have the supreme control of the fishing industry in this country.

16075. (*Mr. Power.*) Parallel to the Board of Agriculture, do you mean?—Exactly. The fishing industry, as a whole, is a very enormous affair, and is a large undertaking.

16076. That would be for fisheries as a whole, not merely shell fish, but all classes of fisheries, of course?—A good strong Fishery Board should be constituted, in which the public and those interested could feel confidence. Such Board should have control of all classes of fisheries.

16077. (*Chairman.*) Was that not provided for by the Fisheries Bill, 1899?—No, it was not so provided for to knowledge.

16077*. Then you ask that a new Bill should be brought in providing some such Board?—I do, and giving them supreme control of the whole of the fishery interest.

16078. Then, as to the constitution of that Board, what would you recommend? Would you have an expert on it?—Yes, I should have experts, such as the gentleman I see on your right, Dr. Bulstrode. I certainly should have such experts as him.

16079. And otherwise?—I beg your pardon.

16080. The other persons?—I prefer not to name individuals.

16081. No, but generally?—Gentlemen of that description. I should also include the inspectors at the Fishery Department of the Board of Trade, who have a very great knowledge of fishing and fishery interests. I should certainly recommend these to be on any such Board, and then I think, in order to give all classes confidence, it would be well that a certain number of the Fishmongers' Company should be included on it.

16082. Then what sort of control should you give to such a board?—I should give them absolute control, the same as the Marine Department of the Board of Trade exercise over shipping.

16083. Now, coming to the question of sewage and oyster beds, you suggest that discharging sewers should be removed from the neighbourhood of oyster beds. I suppose you would found that argument on the fact that the oyster beds have been in the position very much longer than the sewage outfalls?—Exactly.

16084. You think you have a prescriptive right to the ground?—I think so.

16085. I suppose you would put a case of this kind—that an oyster bed which has been in existence several hundreds of years should not be disturbed. Take the case of a village. A village constantly grows, and becomes a town, and there are sewage works constructed which discharge into the stream or into the sea in the neighbourhood of your oyster-beds. Is it not very largely a question of the convenience of the greater number? But supposing your town were fairly large, would the disposal of its sewage be a greater benefit than the persistence of the oyster culture in the district? It appears to me to open up the question of relative interests. The oyster culture in the district is worth so much money, the convenience of the public is worth so much money. Which is worth most?—In viewing this subject, if you will allow me to say so, we ought to take a broad view, viz., the oyster planter and public health. I take it that oyster planters, and indeed, all shell-fish industries, consider that the public health de-

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mands that all crude sewage ought to be treated before going into any place near any oyster layings or shell-fish layings of any description.

16086. I do not think that the mere treatment of sewage would remove the difficulty. In the ordinary sewage outfall, even supposing the bacterial system to be used, the effluent at the outfall is full of bacteria. How are we to be certain that there are no bacteria at the outfall harmful to human health? It would involve the purification of the outfalls as if they were going to be used for drinking. The difficulty is very great?—I quite agree. The effluent might not be perfectly harmless, but I think we have come to this conclusion, that it would be very much better than the crude sewage which is being discharged to-day.

16087. Yes, no doubt?—Then the further question arises in my mind, that is, whether the effluent which is being discharged is better than the decomposed crude sewage which goes into the sea. That is a question I cannot answer definitely, but the sea-water, I suppose, being mixed with it, would render it harmless.

16088. Certainly, ultimately; but it may flow into the sea over your oyster-bed, and it is impossible to say that disease germs are not carried into the sea over the oyster-bed from the sewage effluent which may look perfectly pure and be chemically suitable, and still contain large numbers of microbes?—Still, the treatment of sewage is a better system, and the public have looked upon the other as a barbarous one. Surely the time has arrived when something ought to be done to allay this scare in the public mind from which the oyster industry has suffered so very severely during the past few years. I have been connected with the oyster industry for many years. In 1887 there was a Select Committee appointed in order to see whether a close time would help the oyster industry, and the Select Committee recommended a close time. That close time has been observed for the English oyster ever since. Parliament has also conferred upon the Board of Trade powers to grant "Several Orders," so that oyster culture might be encouraged. All these things have tended towards the increase of the oyster. A few years ago, or previous to this legislation, the oyster-beds were becoming depleted, but to-day there are more English oysters than there have been for the last half century round our coast. Parliament has taken these steps, but the British public now are precluded from the enjoyment of an article of food which is a nutritious one because of this sewage scare. Probably they say, rather than run the risk, we will do without the oyster, and we are very apprehensive that all this legislation which has taken place is going to be null and void unless something is done to restore public confidence, and that can only be done by seeing they have a pure article.

16089. Then your argument is, we are to treat the sewage so as to remove all possible danger to the oyster-beds, and then allow the pure water to run over them?—Yes.

16090. (*Major-General Carey.*) Would the public be satisfied with that?—Yes, I think so, if we say this is the best system that can be devised, and I take it science is not going to stand still; then surely if that is the case, and the oyster planter has done all that he possibly can, I think the public will be satisfied; but I would not stop there. I would say that if, in the opinion of this new Fishery Board, the effluent was detrimental to the oyster-bed, that they should "shut it up and close it." The oyster planter to-day says, "We want a clean bill of health, and if there is any doubt, shut it up until such times as all sources of doubt are removed."

16091. (*Chairman.*) Could you, from your experience, say whether there are many oyster-beds that ought really to be closed in that way?—There will not be many.

16092. There will be a few, I suppose?—There will be a few. Take this valuable report of the Local Government Board, which I daresay you have had before you. That valuable report was made after the last scare, and what has been the result? Nothing whatever has been done, and to-day we are suffering more than ever. The scare is more acute to-day than it was at any time during the last scare.

16093. Then you think it would require that very large sums should be paid in compensation?—I do not anticipate any very large sum. I should say it would be a small sum that would have to be paid as compensation for the closing of contaminated oyster beds.

16094. Would it be possible to shift oysters from one place to another? For instance, if it is necessary to keep the beds closed, you might have to shut up for two years on an acknowledged polluted bed, and transfer the contents of that bed to another?—You mean removed from one to another.

16095. Before selling?—Yes; that is quite possible, and, in fact, it is being carried out to-day. In the case of Emsworth, all the oysters are being removed from where they were contaminated to a clean bed.

16096. Is there any evidence to show that an oyster thrives upon pollution? It is to a certain extent food?—I cannot possibly conceive that an oyster will thrive on pollution. I believe the public have got it into their mind that it will, but I leave it to the scientists to say whether it is actually so or not. My opinion, however, is decidedly against such a theory as the oyster is clean feeding and soon throws off all impure matter.

16097. We know that numbers of fish congregate round the outfall at Barking, making use of what comes out of the discharge there. Is it not possible that such discharges may really fatten oysters, and that it may be desirable to keep them in such a place until they have reached maturity, and then to remove them and give them a chance to recover their purity?—I cannot possibly conceive that an oyster would thrive under such conditions.

16098. (*Mr. Power.*) But you do not find the sewage is deleterious to oysters, do you?—I have had no experience with sewage-polluted oysters. With regard to my company, our beds are two miles from the shore, and free from all sewage, and our oysters are beautifully fished, so I cannot conceive they thrive best or at all in polluted sources.

16099. Not in your own particular company?—No.

16100. But from what you know of the matter, you would not say it retarded their growth or affected their fattening immediately?—Sewage pollution is not the natural food of the oyster, but something much more delicate and nutritious.

16101. (*Chairman.*) You suggest here that oyster merchants should not make any contribution towards the purification of the sewage that flows over their beds, but it should be done by the public for the public good?—Yes.

16102. That is to say, that it should be done by the corporation or done by the authority in each district?—Yes; I think so.

16103. (*Major-General Carey.*) But if the beds have been put down near the outfall or below the outfall after the sewer was made it would be rather hard, would it not, to make the district compensate the oyster merchant?—That is an exception, and I think there are reasons for saying in that event they ought to contribute something; but I do not know of a single case where any oyster bed has been made near any sewage outfall, but I know of plenty where sewers have been brought to the oyster beds.

16104. (*Colonel Harding.*) Where a sewer is brought to an oyster bed which has been established for some time, is there any remedy at common law applicable to oyster merchants?—I believe there is a remedy. I believe in the Chichester case they got damages, 40s., but the expense of promoting the action was considerable.

16105. On the other hand, do not you find that local authorities take into consideration the development of an industry in the neighbourhood like the oyster industry? Is it not to the advantage of the authority that such an industry should be regulated and put under its authority, and may we not presume that there is another party who desire to injure that industry by discharging sewage over it?—The popular man on the council is the man who shows the ratepayers the cheapest way of carrying out the system, regardless of what it is going to do. It is very sad, but such is my experience. Take the case of Emsworth. A man for two years has been battling with the Emsworth Council to do away with the discharge of crude sewage near his oyster beds, but nothing has been done to remedy this, and to-day his industry is ruined.

16106. (*Mr. Power.*) Are the oyster merchants usually large ratepayers in the districts in which their business is situated?—Not very large.

16107. They are not rated on their holdings below high

water mark?—They are nothing in comparison with the railway companies.

16108. (*Chairman.*) Then, coming to the question whether polluted oysters produce disease, you think there is no doubt of it? You take it for granted?—I should not like to seriously contend that they do not cause or produce disease.

16109. Would you suggest that these beds should be regularly surveyed, probably by officers of this Commission?—I think it is highly desirable that they should be surveyed at least three or four times a year, because the conditions may alter and vary.

16110. There would be no difficulty in carrying that out, providing a Board were appointed. Turning now to military barracks, are they a source of pollution to the coast? Naval ones we can imagine would be. Are they an active source of pollution? I should have thought that everything in the neighbourhood of a military establishment is pretty well looked after?—I am given to understand that the new naval hospital at New Brompton intend running all their sewage into the Gillingham Urban District drains, but there is a large amount of crude sewage discharged into the Medway from the dockyard, etc., which ought to be stopped. Dockyards, etc., should be subject to the same conditions as District or Borough Councils.

16111. Is there any effort made to purify it?—No.

16112. It is discharged direct into the tide-way, I suppose?—Into the tide-way.

16113. (*Major-General Carey.*) Does the sewage flow over oyster beds?—There are oyster beds in the Medway, but they are nearly all up creeks, and possibly it does not affect them. I think the discharge of crude sewage into a confined river like the Medway, and especially where dockyards are concerned, where there are a lot of ships and sometimes a great number of men, that the sanitary conditions ought to be looked into.

16114. (*Chairman.*) Obviously; but we have been speaking entirely of oysters. Do your remarks apply either to mussels or cockles? I presume they are not laid down, are they?—My remarks apply to all kinds of shell-fish.

16115. Both for fishing purposes and eating purposes?—For edible purposes.

16116. But I suppose the same remarks would apply to them as to oysters?—Certainly.

16117. One often hears of cases of illness arising from having eaten mussels?—No, I think you mean cockles.

16118. They have always been boiled?—I think so. With regard to Leigh cockle industry, that is at a standstill at the present time, because of the pollution which has been found to exist there, and the Fishmongers' Company, under their powers, have absolutely stopped any sale whatever in London.

16119. Is it not the case that both mussels and cockles are gathered along the shore, wherever they may happen to be?—Yes.

16120. It would be impossible to lay down any regulations to prevent the shores being polluted at any particular point?—There ought to be, and I hope soon will be, a law to prevent the pollution of shell fish layings. It is the polluted ones that want dealing with at once.

16121. I understand you to say that most of the mussels and cockles are not laid down at all, but are simply gathered where they exist?—They are gathered in certain districts and brought to a central place, where they may become polluted.

16122. So they are stored?—They are stored for a time.

16123. For how long; until they sell?—Until the market takes them; perhaps for a day, two days, four days, as the case might be.

16124. And your contention is that they should be stored in places where there is no pollution?—Exactly.

16125. And they should also be inspected by efficient officers?—Yes.

16126. (*Colonel Harding.*) This question of final storage is most important, is it not, in the life of an oyster?—It is most important with regard to the storage, second only to the layings.

16127. Storage takes place in the package for the railway and in sending up to town, and really the main condition is not so much the beds where the oysters are laid down as the places in which they are stored immediately before their despatch. Is not that so?—Yes; that is so, and that is where the difficulty and the danger arises, and I should be glad if you will allow me to put a case. I think it would be desirable that if this Fishery Board was established powers should be granted to them whereby all shell fish shall be under the inspection of officers who can see, not only to the beds being pure, to the storage being pure, and so on, but that they should be kept in sanitary places and under proper conditions; I have known instances where oysters have been sent from a perfectly pure bed, but their surroundings have been very unhealthy. It is not only the beds but all places where oysters are stored or kept for sale that I think should be under proper control and supervision.

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16128. (*Chairman.*) Would it not simplify the problem very much if you were to legislate on the ground that the storage must take place in pure waters. You say it takes a comparatively short time for an oyster to throw off any disease germs. It has been suggested some three weeks. Would it not simplify the matter if it were enacted that all oysters should be stored in pure unpolluted water for a certain time, as is done with the Americans? Would that fact interfere with the beds? We have similar regulations in connection with a totally different subject. There are certain places where dynamite may be stored. You or I could not buy a quantity of dynamite and keep it in the house. One has to get a permit to store it. There is pretty much the same regulation with regard to spirits; we are not allowed to keep more than a certain quantity of spirits without certain restrictions. Would it not, in your opinion, be a great improvement if it were enacted that no oyster could be stored unless stored in places known to be pure?—I agree that all oysters sent to the market should be from pure beds. My company is, I think, a very good example of a good oyster-bed. An oyster is fished in proportion to its surrounding conditions. Supposing, for instance, my ground was polluted, and I have to remove the oysters to some pure bed, it does not follow that the oyster is going to be in anything like the same condition after being removed, because he might become there almost skin and water. That is a difficulty you have with reference to an oyster.

16129. They fall off very quickly?—They fall off very quickly—in their fish. We sometimes have that condition on our beds. We have one year in about every fourteen when we have practically very little fish, indeed, so much so, that our takings drop more than half. How to account for it I cannot say, unless it is an absence of nutritious food. The oyster is as good as ever he was but he is not well fished; he is not plump, and although he is pure he is not in demand by the public.

16130. You wish that the question should be taken up in connection with the consideration of the various sewage schemes?—Certainly, on behalf of the oyster planters, who are unanimous. I am asked to urge that in the strongest possible way.

16131. And, instead of prohibiting the passage of the sewage directly into the sea, you would suggest the shutting up of beds which are near the sewage works until such steps are taken as may make the sewage comparatively harmless?—Yes, I think the time has arrived when these scares ought to be put an end to, and that the Government ought to step in any say, "We will close down every bed that is contaminated, and no bed shall be allowed to re-open again until such time as the Fishery Board certifies that it is fit for carrying on oyster culture.

16132. (*Colonel Harding.*) Your experience goes to show that if that policy were followed there would not be very many oyster-beds interfered with?—I think there would be very few. It is the few that are doing the injury. Now, take my case. We have got a pure bed and pure water thereon, certified by Dr. Klein. Is it not hard on us and all others who have a fit, proper, and pure bed, to suffer from these scares for the sake of a few. We, the oyster merchants, say we do not care who the person affected is; whether it affects A, B, or C, we are all willing to come under this restriction, and wherever the Government find a bed which is polluted, close it and shut it up until such time as all possible sources of pollution are removed.

16133. (*Mr. Power.*) Has it been alleged that your oysters have caused typhoid fever?—No single case has to my knowledge ever been proven.

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16134. You are not expecting that your beds would be condemned on the survey at all, are you?—Not at all.

16135. Nevertheless, though no disease has been traced to your oysters, your business has suffered through the scare?—It has. The public say, what guarantee have we got if we go to A or B's shop that we are going to have a pure oyster? and, rather than run the risk, we will not touch them. All the very best clubs and shops are experiencing this one fact, that a great many have given up eating oysters solely on that account.

16136. Then there will be the additional advantage from a survey, that not only would those beds which are dangerous be closed, but there would be the guarantee of the other beds being safe beds for use?—If the steps which I have suggested were taken there would be the guarantee to the public, who would say, "Now we know very well that we can get an oyster which is pure, and, consequently, the oyster industry would be benefited, and the oyster would become, not a luxury, as it is at present, but a nutritious article of food, which it was intended to be.

16137. (*Major-General Carey.*) Should that guarantee be given by the Fishery Board?—Yes, I think so. They should have power given them to deal with it. The oyster merchants and the oyster planters are willing to come under those conditions to-day. We have had several meetings, and we have not had one that has said he is not willing to come under those restrictions.

16137*. Would the condemnation of foreign oysters coming from an affected or contaminated source also be left to the Fishery Board?—I think so. I should leave everything to them, otherwise difficulties and muddle will be sure to arise. I think you ought to invest the Fishery Boad with supreme control from top to bottom.

16138. (*Colonel Harding.*) Would it not be a very costly department, involving a very large number of trained inspectors?—No, I think not.

16139. Is the oyster fishery concentrated in certain districts round the coast, or is it spread generally round the coast?—There are not very many of them, and are fairly well concentrated. Take, for instance, the native trade. That is all within the estuary of the Thames on the Kentish and Essex coasts.

16140. What leads to the selection of one district rather than another in laying down oysters? Is it the quality of the food available for them, or the nature of the shore, or what is it?—There are several conditions which have to be taken into consideration. We find one bed that is well fitted and adapted for the production of oysters, we find another which is well adapted for fattening, and we find other beds about equally good for breeding and fattening.

16141. It occurs to one that an oyster merchant might start his industry in some place quite remote from populations and where there would be very little danger of pollution from any sewers, and that possibly in that way he might have an advantage over others in the old positions which had become untenable?—There are very few places suitable, I may say, I think, without fear of contradiction, that every place that is suitable for the cultivation of oysters is taken up to-day, and has been taken up many years ago. The late Frank Buckland knew about oysters, and the conclusion that he came to was that he could start an oyster company about four miles from ours, off Herne Bay, and the result was a complete failure.

16142. Was that due to the unsuitability of the spot selected?—Yes, although it was so near to us. For instance, our Royal Whitstable native, if we were to remove him half a mile east, west, north, or south of its position we should not get anything like the same oyster, either in flavour or rotundity of shell.

16143. It is your opinion distinctly that the locality is of the greatest importance with reference to the oyster industry?—The all-important thing is the position, and I should not know, if anybody asked me, where to go and commence a new place for the cultivation of oysters. I should not like to risk a penny in any such undertaking.

16144. Then is it not possible that an important company like that you are connected with—an old company with a quarter of a million capital—should look after its own interests to some extent by preventing sewage outfalls within an unreasonable or dangerous distance?—We are looking after ourselves, but we cannot be responsible for the places which have caused the mischief and been the means of doing so much injury to the trade generally.

16145. Important companies like yours are able to protect themselves probably either by local interest or otherwise?—We have successfully protected ourselves against anything of the sort, but the case of Emsworth is one which clearly proves that legislation is necessary.

16146. You suggest, as a final solution of this difficulty, that inspectors should be appointed to condemn polluted oyster-beds. There does not seem to be any necessity for action by way of compelling the sewage treatment in the case of populations living on the seashore, does there, if the cases are so rare as you suggested to us where oyster-beds are polluted by sewage? And you also suggested to us that the case would be met if these were condemned?—I would first close the polluted oyster beds, and then compel the sewage to be treated.

16147. If that course were followed there would be no necessity to bring more pressure on the populations on the littoral to spend large sums on the purification of their sewage?—I am glad you have raised that point, because I hope I am not misunderstood. I am here to say that it would be a good thing if all sewage was treated. I see, however, grave objections to this, but I do press this one point, that where a sewer is discharging crude sewage near an oyster bed and is liable to cause contamination, that it should be dealt with at once.

16148. Or the oyster-bed should be closed?

(*Major-General Carey.*) That applies to Ireland as well as England?—Yes, closed and the sewage treated.

16149. There is an oyster industry in Ireland as well as in England?—Yes.

16150. (*Chairman.*) You state that you are ready to explain why you would have no confidence in a county or borough council; therefore you propose to have a Fishery Department of the Board of Trade?—Yes.

16151. You think the local prejudice would be too great in the case of the borough council?—Yes, in either.

16152. I will take now the Bill of 1899, where it was proposed that the authority should be the county or the borough council?—That was thoroughly threshed out by the trade, and the trade came to the conclusion that they could have no confidence in a body of that sort, which would be guided absolutely by their own medical officer. Besides, they are the very bodies that have been the means of bringing the sewage pollution to the oyster beds, and it is not likely they would condemn their own actions.

16153. You think that an outside board, a board that had no connection with the place, would be much more likely to be impartial?—The trade would have every confidence in the Local Government Board. There they feel they are getting away from all local influences, and are dealing with an impartial body. So long as the oyster planter can find that his case is going to be treated by an impartial body, he says we have every confidence in that body whoever they may be.

16154. You make some provision here also that the proprietors of a bed should have some say in the matter, I presume. It should not be done in a high-handed manner, without the whole case being heard?—I had in my mind then the Bill of 1899, where, if a bed had been closed, the owner of the bed would have the opportunity of an appeal to the Local Government Board. I understand that the medical officer of health for the district goes to a certain bed and condemns it; the fiat goes forth that such-and-such a bed is condemned. Under these circumstances, what would be the use of my appealing to the Local Government Board, or whether I succeeded or not? The public have got it that my bed is condemned. I ought to be in a position, at the time when there is any doubt thrown upon my bed, to be able to appear upon the scene, to be able to put forth my reasons and not be condemned unheard.

16155. Then you would have the proprietor summoned before this board to show reason why his bed should not be closed?—Exactly.

16156. I see that already the sale of oysters in London has been prohibited from a number of places?—Since this present scare, yes.

16157. Within the last few weeks?—Yes, that has been done, and that emphasises my point that what the

Fishmongers' Company acting with the oyster merchants have been able to do for London ought to be done for the rest of the country.

16158. Are they compensated?—Not at present.

16159. What are to become of their oysters?—In the case of Emsworth they are being removed to Hayling Island, but with regard to others I am not able to say.

16160. So it would be possible to make use of those oysters from condemned beds. They could be moved, and in due time these oysters in a perfectly clean bed would become an article of food fit for consumption.

16161. Has your Company done anything to prevent their being sold locally?—No, nothing.

16162. The fact of their being prohibited in the London market does not necessarily prohibit them being sold in the provinces and in your own town?—No; and that is the reason why I want this Fishery Board. The Fishmongers' Company will protect the public in London, but they, I believe, have no powers outside London. The action of the Fishmongers' Company practically means the closing of a bed, because we, as oyster merchants, say that we will not buy an oyster from a bed that is proved to be contaminated. When they know that, they know it is no use sending them to Billingsgate. It is practically the closing of the bed.

16163. Has there not been a large market over the rest of the country? Does it not mean they are sold elsewhere? If you prohibit the sale of such oysters in London, does not that mean that they get distributed over the rest of the country?—I think not, because it is well known that the oyster planters are not all residing in London. We had oyster merchants coming from all round the coast at our meeting at Fishmongers' Hall, and they were unanimous in the decision we arrived at.

16164. Who acquiesced in this decision?—We were all unanimous in this decision. We are not like we were a few years ago; then there were only a few that desired legislation, but now we have come to the conclusion that it is highly desirable.

16165. I think Colonel Harding suggested that the inspection might be rather expensive. It occurred to me he would be right if you proposed that the inspectors should visit all the places where oysters are for sale. Oysters must be sold in enormous numbers in shops on a small scale. Is it possible to inspect those places?—I think so. Why should not oyster shops be visited the same as grocers' or any other shops? Why should not the oyster shops be worthy of as much consideration as the grocers'?

16166. A very large number of officials would surely be required if you are going to visit all the places where oysters are sold on the retail scale?—I think not. Take the City of London, for instance, I think that two inspectors would do the whole of the City of London.

16167. Would you intrust the work to the local sanitary inspector?—I think he ought to be an inspector who has special knowledge of shell fish.

16168. (*Colonel Harding.*) I was going to ask, if I may, what would guide the inspector? What would lead him to doubt that the oyster was practically a sound and good one?—There are a good many things.

16169. I mean that it is good in the sense of being free from polluted matter. An oyster might be a perfectly healthy oyster, and at the same time convey pollution by pathogenic organisms. What is there to guide him in saying: "I suspect this oyster. I shall have it analysed"?—The first consideration with a man who knows anything about oysters would be to look at the place in which the oyster is temporarily stored, the bed from which it came, and satisfy himself generally that it was pure.

16170. His inspection then would not be any more guide to the pollution of oysters than as to the local condition of the shop?—And the way in which they are stored.

16171. That would be another important factor?—Yes.

16172. But the main question that we are considering is whether the pollution of oysters by sewage matter in beds should be in the hands of the local inspectors. You are speaking as to whether the Government should overlook them at all?—No, I was assuming that the oyster beds had been put under proper conditions.

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16173. For that you would have another set of inspectors?—I do not want to multiply inspectors indefinitely, but, I take it, the Board, constituted as I propose, would have, say, half-a-dozen inspectors; and, I take it, those inspectors would be able to do the whole of the oyster industry in regard to the closing of the insanitary beds and looking after the shops where they are stored. Customers of ours have complained: "Our oysters are not near so good as Mr. So-and-So; how do you account for it? The flavour is not near so good." I have visited the place, and have found the surroundings have been anything but right. Since those surroundings have been removed the oyster has been quite different. Again, there is the storage of oysters in shops. Take, for instance, the months of September and October, when the vegetable growth on the shell is becoming decomposed. Take such an oyster and put him in a tub amongst two or three hundred others, and I will not say myself, but you gentlemen ask your scientific advisers what the conditions of that oyster would be with that decomposed matter going into it. I have seen such conditions; therefore, I say it is imperative, not only that the oyster beds should be looked after, but that you should trace him from the bed to the time when he is offered to the public.

16174. (*Chairman.*) I suppose the difference is in the flavour?—Yes, and the liability to become contaminated. There is that liability.

16175. Would you do the same with the cockles? Would you have them under inspection in the same way?—I think so. I think all shell fish should be under inspection.

16176. It appears to me the barrows would be very difficult to inspect from which the costermongers sell their fish?—I do not think they would give much difficulty.

16177. You speak of the spratting industry having been destroyed by the action of the London County Council in putting their refuse on the Barrow Deeps?—Yes, that is so.

16178. Is it not the fact that their refuse is very much sought after by fish as food?—Not to my knowledge. It practically destroys the fishing ground wherever this refuse is deposited. It is a terrible state of affairs that the London County Council should be allowed to discharge their rubbish and sludge into the Barrow Deeps, contaminating the water. Look at the hundreds of fishermen who used to be able to catch sprats there, and are unable to do so to-day.

16179. Is that because of the water being rendered less transparent, do you think. Of course, most of the detritus that goes up there is London mud?—That discharges into the Barrow Deep.

16180. Yes, sludge?—And various other matters.

16181. All kinds of refuse, mostly mud?—All kinds of refuse.

16182. I am told there is no sign of any deposit on the sand there at the bottom. In taking soundings, for example, they get up fine sand?—That is true, but it is a remarkable thing that what had hitherto been good fishing grounds have been destroyed through this refuse being dumped there. I quite acknowledge this is a very large question. I was first associated with it when they discharged it at the Nore, and it was then that the fisheries committees were appointed under the Local Government Board Act, which gave us powers to deal with it. It was a compromise of evils when the Kent and Essex Sea Fisheries Committee sanctioned the London County Council depositing in the Barrow Deep. We thought it a very good step in taking it down from the Nore to Barrow Deeps; but when we come to consider the whole of our fishery interests, and in the light of recent events, it is not a fair thing now, and the time has come, I think, when that ought to be stopped.

16183. Is it perfectly certain that the fish have absolutely gone away from there? Is it perfectly certain that the deposition of this sludge has been the cause of the decay of the fishing industry?—It is stow-boats especially are unable to fish there for the reason that one of the County Councils steamers discharges a thousand tons at a time, and there are, I believe, four steamers discharge every day. The result being that if their nets were down they (with the action of the tide) would soon be full of rubbish.

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16184. It is not so much that the fish are frightened away as the nets are filled with rubbish?—The rubbish gets into the nets. Then there is another point which I think desirable of consideration, and that is whether the fish in these filthy surroundings are not liable to cause some disease to the public.

16185. (*Chairman.*) Whitebait, for example?—No, sprats.

16186. (*General Carey.*) Are the cockles, which are brought for sale to London market, delivered in a raw state, or are they cooked before they come up to London?—They are principally cooked I believe, but I am not certain.

16187. Before they come up?—Yes.

16188. But they are brought for sale just the same?—Certainly.

16189. (*Chairman.*) You do not think that cooking destroys the microbes?—I should not like to say.

16190. Are they lightly cooked, or do they reach boiling point?—I cannot say; but I am quite certain of this that the Fishmongers Company would never have taken the responsibility to stop the sale of these cockles unless they were convinced that they were unfit for public food, because, while their first duty is to the public, they have at the same time done their best in the interests of the trade; I must acknowledge that on behalf of the trade generally.

16191. (*Colonel Harding.*) I should like to ask you as to the powers of the Fishmongers' Company. We understand that they are limited to London?—Yes.

16192. Is it greater London or the City of London?—I believe the City of London.

16193. Not greater London. Then has the Fishmongers' Company the financial means of undertaking the necessary inspection of the oyster fisheries?—They have no jurisdiction whatever, I believe, to deal with fisheries outside London. If anything is brought into the City of London which is unsatisfactory for human food, they can at once stop the sale of it, and condemn it.

16194. If that were published, if it were known generally at the Fishmongers' Company that a certain source of oysters was considered to be polluted, and that they had begun the necessary action in London, would not the effect be also to limit the sale of oysters elsewhere outside London?—I think, in conjunction with the oyster planters, they have done a great deal more than one might have expected since the scare. They have taken samples of oysters and water from different layings, and submitted them for analysis, and wherever the report has been at all unfavourable no shell fish have been sold therefrom.

16195. Although the Fishmongers' Company has not the necessary powers to enable them to go out of their jurisdiction to appoint inspectors, you think it is possible by some voluntary arrangements amongst the oyster merchants to bring about an inspection by them?—No, I do not, and I do not think they should be called upon to do this work either by themselves or in conjunction with the oyster merchants. I cannot possibly conceive that anything they might do would allay this scare which has taken such a deep hold on the public mind.

16196. You think it must necessarily be a single Government Department which must undertake this?—That has been my impression right through.

16197. On the point of compensation you said that if an oyster bed was closed, or I gathered from what you said, that there ought to be in such a case compensation?—I do.

16198. Obviously for that particular oyster bed if the owner had been grossly careless he would not deserve compensation, but, on the other hand, if he had used reasonable care, and some sanitary authority had poured out sewage in his vicinity, and acted against his protest, he would seem to be deserving of some compensation if some of his beds were closed down. Have you ever considered the question of whence that compensation should come. Should it be from the local authority?—I have not thought that out very deeply.

16199. Would it not be an advantage that it should come out of the rates rather than taxes, because in that case if the local authority had to pay if they do a damage it might make them more careful in bringing about the damage?—I must say I have not given much thought to it, but I think this would only be a small matter, and I think there might very well be a grant specially set aside the same as the farmer had some time ago.

16200. An Imperial grant?—Yes.

16201. Does it occur to you that it might be possible for the oyster industry itself to provide a fund of that kind?—I do not think the oyster industry should in any shape or form be called upon to do it. Why should it? I have a pure bed. I have suffered enough; and would it not be terribly hard on me to have to contribute to a man whose oyster bed has been found contaminated, and has been the means of causing this scare? The fault is not the man's, but the parties who have contaminated the beds and the Local Government Board have sanctioned many of these schemes. I, therefore, think it is a case for the Government.

16202. It would facilitate the matter, and therefore would be for the general good of the trade?—I have taken this view that it is a public question, and a very grave public question. We know how difficult it is to get money out of the Government at the present time; but I should think that this small fund might easily be set aside for a purpose of this sort. I do not think every case would be one for compensation., but I think that the party whose bed is contaminated ought to prove satisfactorily to the Fishery Board that he is fairly entitled to it, and has done everything that a reasonable man can do, and if they satisfy them that sewage has been poured over it and caused this pollution, then I think that should be a fair casee for compensation, but not otherwise.

16203. You evidently think that the amount to be paid in righteous compensation would be very small?—I do.

16204. And finally just this. We are to gather from what you said that there is, on the part of the oyster trade, now a growing feeling that it is most important for them to protect the sources, and to guarantee the safety of the oysters they sell?—That is so, I represent to-day the unanimous expression of opinion from the oyster planters round the kingdom, who are anxious that something should be done, and I have also to impress upon the Commission how desirable it is that this matter should be taken in hand at the earliest possible moment.

16205. (*Chairman.*) I was going to ask you about that. You wish the matter adjusted as speedily as possible, but what I had in mind was that, if such a Commission or Board, as you recommend, were appointed, the appointment of suitable members would take a long time. Is there any Board in existence which could be entrusted with such a matter?—I would suggest representatives from existing bodies, say two or three from the Local Government Board, two or three of the inspectors from the Fisheries Department of the Board of Trade, and representatives from the Fishmongers' Company.

16206. Would it want legislation to constitute such a Board. I think it would?

16207. To get legislation on such a subject involves delay. I presume it would be required to be brought in as a Government measure. I do not know?—Possibly it might require legislation.

16208. (*Colonel Harding.*) The Local Government Board would not have the necessary powers at present, and therefore they could not take the action which you suggest, unless they were strengthened by a Bill?—There must be special powers, I believe.

16209. (*Chairman.*) Is there any one of these bodies that you have named that could be entrusted with these powers? It would obviously be much easier to delegate the work to a body or bodies already possessing powers than to create a new body?—Yes; but I cannot possibly conceive that the Local Government Board would be willing to take such a burden, neither can I think that the Fishery Department, as it is now constituted, would. We want to be scientific, and practical, and we also want those who have hitherto had some experience in these matters. If we could get a Board of that sort, it would command universal respect, and I think that their decisions would command that respect from all classes, and allay that public scare which is so rampant to-day.

16210. I am afraid, as far as I can see, you are between two stools; you want rapid action on account of the public scare, but you propose a scheme which would obviously take a long time to develop before it would come to bear any fruit?—What we say is, let us do it thoroughly, and if it takes six months we would rather give the six months now than have these scares cropping

up again. This is the position during the last five years, ever since that last scare we have been sitting, as it were, on a safety valve; and, just as our trade was at its highest this unfortunate scare has come again, and caused a profound distrust in oysters generally.

16211. (*General Carey.*) Of course, any decision which might be arrived at, either by a Government Department or a Board as you suggest, for compelling local authorities to treat the sewage before putting an effluent into a tidal water, we will say, over an oyster bed, would take some time. Even if they had the very best intentions, it might be a matter of a year or more before they would be able to do it?—Yes, that is true, but it has got to be done before public confidence is restored.

16212. And in the meantime, of course, these oysters would still be in a prohibited class?—I am glad you raise that point. I was in hopes that I had made it perfectly clear to the Commission. My point is this, that at the earliest possible moment a Fishery Board should be constituted on the lines I have suggested. All beds closed that are found to be contaminated, and no oysters allowed to be sold unless they come from pure beds. Once the public have this assurance from the highest authority that this is done, then, and not till then, will the oyster industry regain its normal condition.

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16213. (*Chairman.*) We think you want at the same time to have some guarantee that foreign oysters are not being delivered to the English market without some sort of inspection?—Quite so.

Mr. Alderman PETRIE, called; and Examined.

Mr. A Petrie.

16214. (*Chairman.*) You are Mr. Charles Petrie, Alderman of the City of Liverpool, and late Mayor of the city?—Yes.

16215. Would you kindly give us some idea of the proportion between the relative amounts of foreign and native oysters?—I can give you particulars as to the importation of the American oysters, particularly as regards Liverpool, which is a very large centre for the importation of those oysters. Of these I suppose over 90 per cent. that come to this country are landed at Liverpool, and I have a statement, to which I beg to draw attention, of the oysters imported since 1889, showing the importation in barrels. I ought to say that the trade commenced about 1875, and it went on increasing up till 1892, when an oyster scare came on, and since then the trade has not been so good as it was previously. But from 1898 to 1900 it was better than some years previously, and then it came on again. This last year, particularly since before Christmas, it has been particularly bad.

AMERICAN OYSTERS imported since the year 1889.

Season.	Number of Barrels.	Total Number of Oysters.
1889–1890 - - -	122,498	147,000,000
1890–1891 - - -	98,493	118,000,000
1891–1892 - - -	109,235	131,000,000
1892–1893 - - -	68,912	83,000,000
1893–1894 - - -	75,348	90,000,000
1894–1895 - - -	70,067	84,000,000
1895–1896 - - -	78,355	94,000,000
1896–1897 - - -	70,340	84,000,000
1897–1898 - - -	64,249	67,000,000
1898–1899 - - -	74,184	89,000,000
1899–1900 - - -	75,590	91,000,000
1900–1901 - - -	67,174	81,000,000
1901–1902 - - -	60,859	73,000,000
1902–January 22, 1903 -	14,994	18,000,000
	1,050,298	1,250,000,000

We estimate the value at 25*s.* per barrel; of the above 60% are bedded, 40% sold ex ship.

16216. The value of the oysters may be taken as £100,000, I think?—Yes.

16217. Varying between £70,000 and £100,000?—Yes. That is, of course, the gross shipping value of them, and then I estimate that about 60 per cent. of those oysters are relaid in this country. Of course, there has to be about 25 per cent. added on to that ex ship—25 per cent. to 30 per cent.—paying costs and freight, working them in beds, and getting them back again on to the market.

16218. Are they known as American oysters, or do they rank as English oysters?—They are all known as American oysters. There is a peculiarity about the American by which it is known, a black spot in the centre of the shell that can never be eliminated, so that the oyster does not require to be branded. It is a natural brand on it.

16219. Do you know where they are collected chiefly?—They are collected in America from Long Island Sound principally and East River. The two particular sorts that come in the largest quantities to England are the Blue Points (these come from Long Island Sound), and the other, called the East Rivers, is from Connecticut.

16220. How are they packed?—They are packed in barrels, ordinary barrels, something like a flour barrel, about 1,200 oysters on an average in each barrel, and they are packed very tight. They are thrown into the barrels, and then the barrel is put on a very solid foundation, a large stone, and well shaken up, and then the head is put into the barrel. The oysters are then very tight, so that they are not able to open their shells during the voyage.

16221. There is no water in the barrel?—No water in the barrel, no. I may say the oysters are prepared before being packed, and they are kept in running water, taken out of deep water, and put into rather shallow water, remaining days, some a week, before they are packed.

16222. Fresh water?—Yes; that hardens them. They are in flat boats, and the water runs over the boat and hardens the oyster, and makes it better for travelling to the market.

16223. Are they delivered straight to the market here, these which are sold? Many, you say, are laid down?—Yes; about 40 per cent. of them are consumed.

16224. Straight away?—Straight away, yes.

16225. How long are the remainder laid down?—They are only put down on the beds for consumption really during the close season—that is, in the summer months.

16226. I suppose they keep good about fourteen or fifteen days out of water then?—Yes.

16227. On the voyage?—Sometimes more than that. They keep three weeks.

16228. Without drying?—Yes.

16229. Are there any cases of death amongst them?—Yes.

16230. Is not that deleterious?—If an oyster is bad, really rotten, that does affect the others round it.

16231. That does not often happen?—If there is frosty weather, some of them get frosted and die on the way.

16232. Has there been any case of disease from eating oysters, do you think, which have been contaminated in that way?—No; I do not know of any.

16233. You do not recollect any such cases?—No, I do not know of any. I may say that the United States Government are very particular, I believe, with regard to the inspection of the oyster grounds there, and this is a copy of the certificate I got a short time ago from the States Department of the Government. I might suggest that foreign oysters come from other countries, such as Holland and France, and if the English Government were to ask the respective Governments on the Continent to send a similar certificate, that might be of some use.

Mr. A. Petrie.

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COPIES OF UNITED STATES GOVERNMENT CERTIFICATE OF OYSTER FISHERIES.

STATE OF NEW YORK.

Forest, Fish and Game Commission.

B. FRANK WOOD, Supt. of Shellfisheries,

No. 1, Madison Avenue,
New York, 3rd January, 1903.

"This will certify that the oysters known in the trade as 'Blue Points' are taken from beds located in Great South Bay, a great expanse of salt water lying along the south shore of Long Island, in New York State, and, with its extensions known as Moriches Bay and Shinnecock Bay, having a total length of about sixty miles. These bays are from two to six miles wide, and separated from the Atlantic Ocean by narrow strips of sand beach, through which are many inlets, allowing the ocean tides to regularly ebb and flow. The oyster beds are at an average distance of about two miles from shore. The south shore of Long Island is sparsely settled, and there is no possibility of sewage or other contamination.

Dated, New York, January 3rd, 1903.

(Signed) B. FRANK WOOD,
State Superintendent of Shellfisheries."

STATE OF NEW YORK.

Forest, Fish and Game Commission.

B. FRANK WOOD, Supt. of Shellfisheries,

No. 1, Madison Avenue,
New York, 3rd January, 1903.

"This will certify that the oysters known in the trade as 'East Rivers' are taken from beds situated in Long Island Sound, an important arm of the sea extending for one hundred and twenty miles between the south coast of the State of Connecticut and Long Island, in the State of New York, its greatest width being about twenty miles, narrowing to about two miles at its western extremity, averaging about twelve miles wide. These beds are remote from any possible contamination by sewage or otherwise, many of them being at a depth of sixty feet under pure sea water.

Dated, New York, January 3rd, 1903.

(Signed) B. FRANK WOOD,
State Superintendent of Shellfisheries."

16234. This appears to be a sort of officer who has been suggested?—Yes; they have a Commission there, a Fisheries Commission.

16235. A permanent Commission?—A permanent Commission, yes; a department of the Government.

16236. Are those American oysters, immediately after landing, laid down in the neighbourhood of Liverpool?—Yes; they are laid down as shown by the following table. (*See* Table A.) A good many go to the east coast, Cleethorpes, and we have beds at Fleetwood, where we bed largely, and there are some in the Menai Straits in Wales, and also a good many go to Ireland, Howth, Clontarf, Malahide, and Carlingford. Those are the principal layings, I think, and there are more laid down at Brightlingsea.

TABLE A.

OYSTER "BEDS," "LAYINGS," AND "PONDS."

ENGLAND AND WALES.

Essex:
- Southend.
- Leigh.
- Rivers Crouch and Roach.
- The Blackwater.
- The Colne.
- Hanford Water.
- Wivenhoe Storage Pits.
- Brightlingsea Creek.

Suffolk:
- The Orwell.
- The Deben.
- Orford River.
- Butley Creek.

Norfolk:
- Blakeney.
- Wells.
- Burnham.
- Lynn.

Lincolnshire.
- Cleethorpes.
- Grimsby.

Northumberland:
- Budle Bay.

Cumberland.
- Skinburness.
- Whitehaven.

Lancashire:
- Fleetwood.

Anglesey:
- Beaumaris.
- Menai Bridge.

Carnarvon:
- Bangor.

Pembrokeshire:
- River Dancleddan.
- Milford Haven.
- Tenby.

Glamorganshire:
- The Mumbles.

Cornwall:
- Helford River.
- Falmouth.
- Truro.
- Fowey.
- Saltash.

Falmouth:
- St. Mawes Creek (Porthouel River).
- St. Just Creek.
- Penrhyn River.

Devonshire:
- Dartmouth.
- Brixham.
- Torquay.
- The Teign (Teignmouth).
- The Exe.

Dorset:
- Wyke Regis.
- Poole.

Hampshire and Isle of Wight:
- Beaulieu River.
- Hamble River.
- Newtown River.
- Medina River.
- Wootton Creek.
- Emsworth Creek.
- Hayling Island.

Sussex:
- Bosham.
- Shoreham.
- Southwick.

Kent:
- Whitstable.
- Faversham.
- The Swale.
- The Medway.
  - Ham Ooze Oyster Layings.
  - Colemouth Creek Layings.
  - Sharfleet Creek Layings.
  - Stangate Creek Layings.

16237. Not many reach London?—Not so many. I should take it not more than 10 per cent. of the total quantity imported.

16238. Then you say that Portuguese oysters come to Kent and Sussex, and are bedded there?—Yes; there are a great many there, but since I made this statement I have some figures which have been given to me—I do not know that they are very reliable. I give them such as they are. It is reckoned there are about 15,000,000 to 20,000,000 Portuguese oysters that come over now, and about 60 per cent. of those are relaid, if not more.

16239. Is there such a thing as the importation of mussels and cockles, or are they indigenous?—Yes. Mussels come from Holland principally.

16240. For edible purposes?—Yes.

16241. Are these delivered into the market straight?—Those are delivered into the market for consump-

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tion. As regards the mussel industry around the coast, I may say that mussels picked up in strong sea water are not really fit for market purposes. They are not in a good condition. They are generally transplanted during the summer, say April or May, and put into where there is more fresh water, in the estuaries and rivers. Then they are taken up in the autumn and winter, and sent to the market, because the fresh water happens to make them in better condition.

16242. And there is a liability, of course, that the fresh water is contaminated with sewage?—Yes; they run exactly the same risk as oysters do.

16243. (*Colonel Harding.*) What is the nature of the food they get from the fresh water?—It is a sort of plant, I think, or insects in the water.

16244. It seems to be an essential for their fattening process that they should be subjected to the action of the fresh water?—Yes; there is more food that suits them in the fresh water than in the sea, I think.

16245. (*Chairman.*) A good many oysters are brought to this country, as the Americans call it, "canned"—in tins?—Yes; there are a good many tinned oysters.

16246. Do they not produce disease?—I never heard of any; but, of course, they would if the air got at them; they are hermetically sealed.

16247. Do the American restrictions in the paper you have given us entirely prevent such a thing as contaminated oysters in America, or are there any other causes known for the contaminating of the oysters?—Yes, there was a case, which I daresay you have heard of, connected with Harvard College in America a few years ago. There was a banquet given there, and it was said some typhoid fever had sprung up amongst the guests at that banquet, and they attributed it to the eating of oysters; but I do not think it was ever properly traced so as to show that it really was the oysters that gave them the disease.

16248. There has not been an oyster scare in America, has there?—No.

16249. So that these restrictions have protected them a least so far?—I believe they are more particular with regard to oysters being contaminated at the sewage outfall than we are in this country.

16250. They have a larger littoral, of course?—It is an enormous industry in America; but they send the whole of these train loads all the way from New York, Long Island and Newport, and some of those from the East River are sent right away to San Francisco. They open them and put them in cans with blocks of ice. I have seen train loads of them going out.

16251. (*Colonel Harding.*) Oysters are much cheaper there, and are much more used as a popular food?—Yes, they are very much cheaper.

16252. (*Chairman.*) Is that because of the greater number, or why should it be so?—The climate seems to suit them better. They are more prolific.

16253. In the paper that you kindly give in, you give some comments on the Oyster Bill of 1889?—I think they are very much the same as Captain Anderson stated. We were rather afraid of the local medical officer of health being the sole authority to report upon our oyster beds. Some of them are rather against the oysters altogether, and, of course, the local authority employing the medical officer of health is really one and the same thing.

16254. Quite so. You prefer that some central board should undertake the matter?—I would have every confidence in the Local Government Board.

16255. Or such a committee as was suggested by Captain Anderson?—Or such a committee; and I may say I appreciate the difficulty you point out with regard to that particular Commission, the horse would be starving while the grass was growing, so to speak, because, no doubt, it would take some little time to get this Commission together. We could possibly get some authority to take the matter up, so that we might prevent the recurrence of this scare at the present time, by the Local Government Board or some other department of the Government.

16256. Is there any organisation in Liverpool which deals with such matters?—There is no organisation beyond the Municipal Corporation. Of course, they are under the Public Health Acts, and have all sorts of powers of inspection. The medical officer of health takes samples of all sorts of shell fish, and very frequently he has them analysed.

16257. But nothing analogous to the Fishmongers Company?—No, the Fishmongers' Company have no control outside London.

16258. But is there nothing, no body that can cooperate with the Fishmongers' Company?—No.

16259. No organisation of that sort?—No we are not supposed to have rich guilds in the provinces.

16260. You, of course, agree as regards the dangers of contaminated sewage?—Yes. I am afraid I think the fisheries industry of the country altogether is quite large enough an industry to have a separate department of the Government to look after it. I am very strongly of that opinion, the same as Captain Anderson.

16261. I think we may take it for granted that it has been known that oysters have produced disease?—Yes; I am afraid we are not in a position to deny that. At the same time, I think the medical officers very often say if a person is suffering from typhoid fever, "Have you eaten any oysters in the last six months?" and they put it down to the oysters, from what reason I do not know. I do not think they can give any sufficient reason.

16262. (*Major-General Carey.*) A polluted oyster may give rise to other diseases than typhoid fever?—Quite so, and a rotten oyster, like a rotten mutton chop or anything else, will bring about a disease of a sort, but the only thing is, one knows when an oyster is bad when he looks at it.

16263. (*Chairman.*) Do you take it for granted that American oysters are likely to be free from disease of any kind?—I think they are free from disease on landing here. Of course, a good deal depends upon the treatment they receive on landing.

16264. Before landing?—If we put them down on polluted beds, and they are there for six months, they can contract disease.

16265. But you take it they are not polluted when they arrive?—Not polluted when they arrive.

16266. Can the same be said about oysters from Portugal or France?—I am afraid not, of my knowledge, I believe they are not so particular on the Continent with regard to sewage as they are in America.

16267. These companies have no special organisations to supervise their fisheries and oyster fishereis?—Not so far as contamination by sewage is concerned, I understand.

16268. (*Chairman.*) Is there any distinction drawn between mussels, for example, which are used for cooking, and those which are not used for food; are they separately imported; do they reach different dealers?—Mussels that are imported are for bait. They simply come to the fishing ports, such as Grimsby and Aberdeen, and they are a small mussel; they are not a cultivated mussel.

16269. They are not sold for food?—No.

16270. I notice you say in the draft of your evidence here that you have prepared and hand in a copy of a report from the State Superintendent of Shell Fisheries in the State of New York. Is it possible to get any *précis* of any regulations which the Americans have; is this the paper you are alluding to?—Yes.

16271. Is it possible to get any *précis* of the American regulations on the subject; would that help us in any way?—I think it would be quite possible.

16272. Where could one apply to?—I could get it through the American Consul at Liverpool.

16273. (*Secretary.*) You had better send it to the secretary of the Commission, send it to me here, perhaps?—Yes, I could do that.

16274. (*Chairman.*) One would like to see what sort of Bill they had in order to constitute such a Commission, and what it consists of; that would help us?—You would get particulars of the constitution of that Commission, I shall be very pleased to try and get a copy of it.

16275. We have had evidence that the selection of representatives on boards already existing would be

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better than the appointment of a new one; do you agree with Captain Anderson that it would be better to do the thing thoroughly, even if you have to wait for it?—I hope we shall do it thoroughly this time, so that we shall not have to go over it again in four or five years' time.

16276. At the expense of a little delay?—At the expense of a little delay. We are all practically unanimous, and I feel it is necessary to have some legislation on the matter, because without an Act of Parliament there are always one or two of the men who would stand out. However agreeable most of us might be, the odd contrary man in the end can do as much damage as we are doing good now; so I think it would be necessary to have legislation of some sort to compel a person to fall in line with the others.

16277. And you also agree with Captain Anderson with regard to the control that should be exercised over foreign imports?—Yes, I do.

16278. You think that would be possible?—So far as branding of oysters is concerned the packages are now all branded. The American oysters are legibly branded, and have the numbers on each barrel. That is not done in the case of oysters from the Continent.

16279. It could be done?—It could be done.

Mr. J. W. Towse.

Mr. J. WRENCH TOWSE, called; and Examined.

16280. (*Chairman.*) Perhaps you would be kind enough to inform us as to the powers which the Fishmongers' Company possesses?—The Fishmongers' Company have in their possession various charters which have been granted from the time of Edward I., but the charter under which they act is that of James I., under which we have power to supervise all fish arriving in London, Billingsgate in particular, and to see that such fish is fit for human food. We have various meters who have powers granted by deputation in Billingsgate Market to go to various other markets in Shadwell or London, or elsewhere, and the powers of the company are very drastic. Then, we have power, under the Act of 1892, with regard to salmon, and also there is power given us under the 1877 Act (Oyster, Crab, and Lobster), with regard to oysters. Just now, with regard to the scare, we have conceived it our duty to make inquiries generally into the consumption of oysters in the London market, and in order that we might see that they were fit for food, and came from unpolluted sources, we sent our meters to the various places, as mentioned by Captain Anderson and Alderman Petrie. We then submitted the samples of these oysters to Professor Klein for analysis. He reported in most cases that they were polluted by sewage. That being so, we informed the various parties that we could not allow them to be sold in London. In consequence of our action we practically debarred them from being sold anywhere. Also in regard to cockles that came from Leigh, there our attention was called to various cases of illness, typhoid fever, by persons who had eaten cockles last November, I think it was. We had several samples up from Leigh, and Dr. Klein analysed them, and found that they were very strongly polluted. It unfortunately went further, and then we said, "These cockles must not be sold which have been taken from the layings at Leigh; but as we have reason to believe that if taken from their natural beds, the Blythe or Maplins, they would be pure, and if you would boil them immediately they come on shore and not relay them, we will allow them to be sold. In order to be perfectly sure of these cockles, that they were not polluted, I again submitted samples to Professor Klein, with the result, unfortunately, that he found they were polluted. Since we have had experiments as to boiling. After they have been in boiling water for $3\frac{1}{2}$ minutes the bacillus is killed, but, unfortunately, we cannot depend upon the hearsay of one man that they have actually been subjected to the boiling process, and I believe the general system is to place the cockles in a cauldron of boiling water, and there they are allowed to remain until the water is boiling again, but that does not show that they have been subjected to a boiling process during that time. In the experiments of Professor Klein some little while back it was shown that by putting the cockles into water at a temperature of 100° Centigrade it was immediately lowered to 60°, and, therefore, unless we can stand by and see that the cockles are absolutely boiled for over a minute the germ may not be killed, and if in that condition they are placed in the market and there should be any typhoid bacilli they would render the cockles absolutely unfit for food.

16281. Would it be possible for the Fishmongers' Company to get larger powers through the exercise of the powers they have by agreement over the rest of England?—Well, that is rather a matter for Parliament.

16282. Would it not be a matter for agreement if all the oyster growers consented to put themselves under the jurisdiction of the Fishmongers' Company, and that could be done at once?—At the present time there is a voluntary agreement to adopt such measures as we advise, but, of course, at any moment any party may say, "No, I do not agree to that," and, of course, outside London we should be powerless.

16283. Absolutely powerless; but would not anyone who objected to your jurisdiction be self-condemned?—Probably, absolutely.

16284. It appears to me so. Instead of waiting for legislation, which is likely to be a long business, why not take the matter into your own hands by your voluntary association?—What has been done now has been done to a great extent with the concurrence of the oyster merchants, but that would not answer for any very great length of time, I take it; you must have legislation.

16285. It would work until it is possible to get legislation, would it not?—It is doing very well temporarily, but I do not know for how long. I do not know whether it is necessary to mention any particular party or parties, but there are certain parties kicking now, and objecting to the ban that has been placed upon some of their oysters, and saying that if they choose to sell them, we cannot prevent it, except this: that we can take action by getting the local powers to take action, with our concurrence, under the Public Health Acts.

16286. That is cumbersome, of course?—Yes.

16287. But it must be a long time before you can get Parliamentary powers?—No doubt, but surely it may be taken that this would be a non-litigious matter and non-political.

16288. But somewhat expensive?—Not if taken up by Government. You mean to say the operation of the Acts?

16289. Yes?—Well, I do not know that it would be particularly, unless the beds were to be examined as thoroughly as they were on the part of Dr. Bulstrode and Dr. Thresh in 1896. No doubt at that time it was expensive when all was told, but when you have such a large area to go over, and interests so great, it is a point that is worth consideration; in proportion the expense would be very little.

16290. But a permanent Board is always an expensive matter—to run a permanent Board?—True, but I may go further than this. We have been speaking today generally of the oyster trade. There were resolutions passed by the National Sea Fisheries Protection Association at a conference held at Grimsby last year. I have also had a recommendation made by the Royal Salmon Commission that there should be a central body upon whose report the direction of the fisheries of the country depends. Therefore, if you are to appoint a Fishery Board in the one case for oysters, that Board should have the power over these questions of salmon and sea fisheries. Of course you have got the nucleus at the Board of Trade, but at present we know they have very little authority, and to a very great extent their work, and so on, is in connection with harbours and marine subjects, and one moment perhaps the assistant secretaries may be dealing with the sewage, or something to do with shipping, and so on, and at another time with salmon and sea fisheries, and oysters, or whatever it may be.

16291. (*Major-General Carey.*) Would the company consider they have power to close oyster-beds if they found them contaminated?—No, certainly not.

16292. It must be referred to another Board altogether?—Yes.

16293. A separate and independent Board?—We have no power to close any bed.

16294. The power could not be delegated to the company?—Power might be given; but I think, as Captain Anderson said, if the bed were closed of an ancient fishery it would be only fair to give compensation.

16295. I think they have power for the immediate closing of certain beds which were undoubtedly subject to sewage pollution?—Well, at the present moment the Emsworth beds are closed.

16296. How are they closed?—Simply, we informed them the other day we would not allow their oysters to be sold in London.

Mr. J Towse.

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16297. You could not have forced them to close in any way?—Not in any way; but if they say, "We shall sell them, notwithstanding your decision," we could not actually prevent that; but I think we could if we were to proceed against them; I think the magistrate would give the decision in our favour. Still, that is a question which it is rather difficult to discuss at the present moment. That would be under the Public Health Acts.

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